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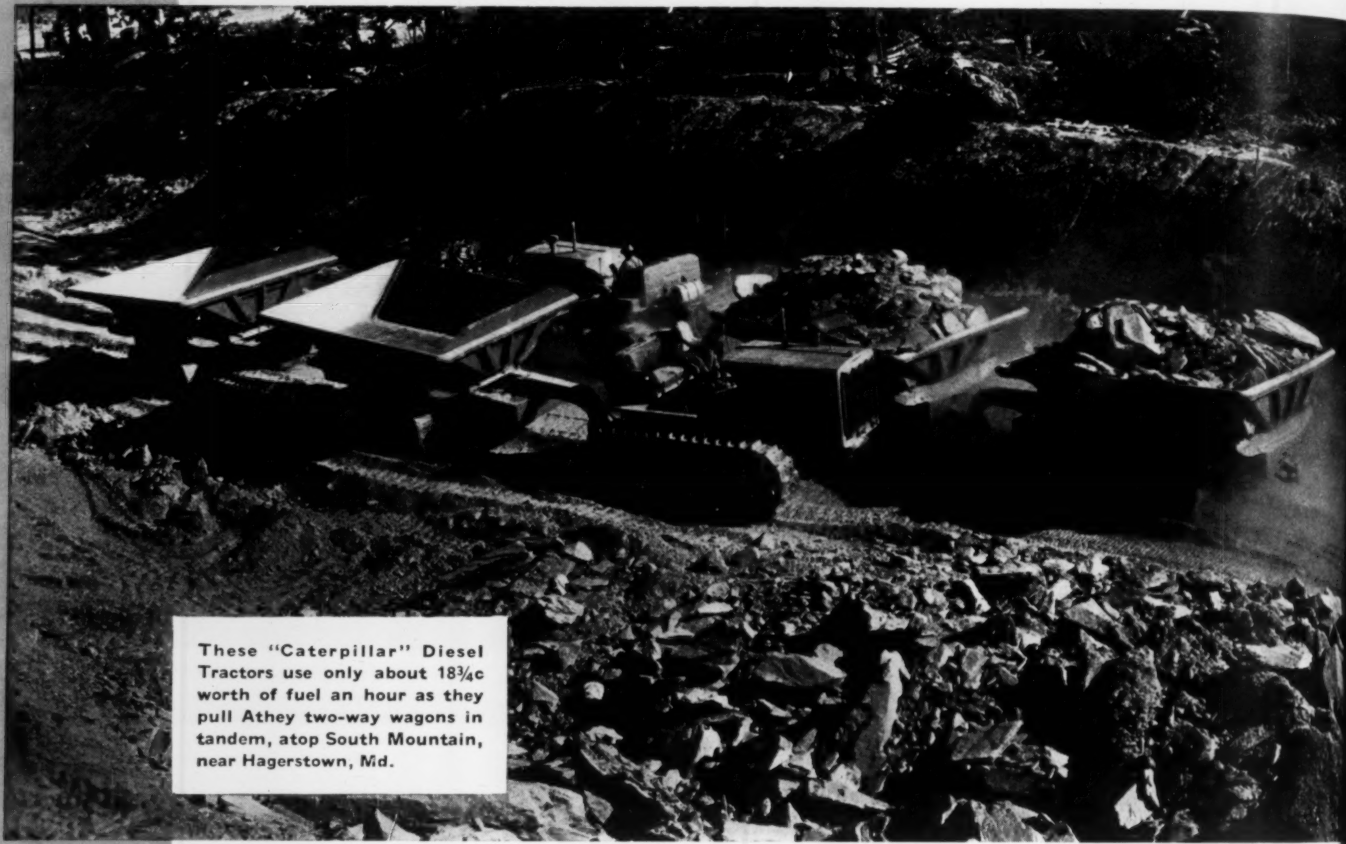
FIRST
—IN EVERYTHING



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Among Our Writers

Oscar Osburn Winther holds B.A., M.A., and Ph.D. degrees, and has taught in all the Pacific Coast states. He is the author of two books and numerous articles on the history of that region.

Thomas M. Robins, since graduating from West Point in 1904, has served continuously with the U. S. Engineer Corps. He is now in charge of river, harbor, and flood control work in the Pacific Northwest and Alaska.

C. D. Riddle, after 7 years in the Civil Engineer Corps of the U. S. Navy and 14 years in various capacities on dam construction, served in 1933 to 1934 as assistant chief engineer on Norris Dam.

R. H. Baldock was educated in civil engineering at the University of Colorado. In addition to 7 years' construction experience elsewhere, he has been with the Oregon State Highway Commission for 21 years, now serving as chief engineer.

O. A. Chase has had 26 years of varied experience in steel-bridge design and construction. He entered the employ of the Oregon State Highway Commission in 1919, and since 1927 has been in charge of bridge design.

G. S. Paxson graduated from Oregon State College in 1912. He has served in various capacities in bridge and other construction work, and has been acting bridge engineer of the Oregon State Highway Commission since October 1935.

Ben S. Morrow has been with the Portland (Ore.) water bureau for 27 years, serving successively as assistant engineer, principal assistant engineer, engineer, and general manager. The Bull Run storage project was built under his direction.

T. B. Larkin, after service with the U. S. Corps of Engineers in Mexico and France, was appointed district engineer of the Vicksburg district in 1930. In November 1933, he was placed in charge of the Fort Peck project.

John W. Haw was active as county agricultural agent and leader in North Dakota from 1913 to 1924, when he went with the Northern Pacific Railroad. Since 1927 he has been director of that road's agricultural development department.

George E. Goodwin has served with the U. S. Reclamation Service and the Engineer Corps, U. S. Army, on river and harbor improvement work in Massachusetts, Montana, and Oregon. He is now in charge of irrigation, drainage, and groundwater studies in the Willamette Valley survey.

C. I. Grimm spent 15 years on the design of dams and flood control works on the Mississippi. Since 1933 he has been in the Pacific division engineer's office of the U. S. Engineer Corps as head civilian engineer for the Bonneville project.

J. C. Stevens has had over 30 years of experience, both here and abroad. For the past 16 years he has been in partnership with R. E. Koon, M. Am. Soc. C.E., specializing in irrigation, hydro-electric development, and sanitary engineering work.

R. E. Koon, after 8 years' experience in water works and sewerage in the Middle West, went to Oregon in 1912 on hydraulic and sanitary work. In 1920 he formed a partnership with J. C. Stevens, M. Am. Soc. C.E., specializing in sanitary engineering.

Carl E. Green, state sanitary engineer of Oregon since 1928, has been very active in state and national public health and water resources associations. He organized the Pacific Northwest Sewage Works Association in 1934 and served as its first president.

Fred Merryfield, assistant professor of civil engineering at Oregon State College, is a member of the streams purification advisory board to the Oregon planning board and secretary of the Pacific Northwest Sewage Works Association.

Harold F. Gray was one of the two engineers who performed, in 1910, the first anti-malaria-mosquito abatement work in California. In addition to his other activities, he is lecturer on public health in the University of California.

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Highlights in the History of Oregon

The Buccaneers; Hudson's Bay Company; "54–40 or Fight"; and Other Interesting Chapters in Brief

By Oscar Osburn Winther

Visiting Professor of History, University of Oregon, Portland Center, Ore.

Spanish adventurers seeking the mythical northwestern passage to Cathay were the first white men to sight the Oregon coast. But almost 250 years elapsed before anyone became interested in what lay inland. When explorations finally began, development was rapid. By 1825 the Hudson's Bay Company was firmly established at Fort Vancouver; 18 years later Marcus Whitman led his caravan into the Willamette Valley; and in another 16 years Oregon became a state. The fascinating story of these years of exploration and development is here retold, briefly and entertainingly, by Dr. Winther. The article is abstracted from an address delivered at the Annual Convention at Portland, July 15, 1936.

One of the most difficult problems of anthropology is to explain the origin of the Red Man—the aborigine of North America. The most generally accepted theory of his arrival on this continent is that he walked across the frozen Bering Strait from Asia. And the best evidence in support of this theory is found among the Indians of the Oregon country. The most plainly discernible Asiatic characteristics are to be found in the relics, customs, and language of the Indian of the Pacific Northwest. The reinforced Tartar bow, the Mongolian arrow, the Siberian rectangular plank house, and moosehair embroidery, are all of Asiatic origin; so are the words toboggan, moccasin, and tipi, as well as many others.

So we may say that the Red Man was the first "discoverer" of Oregon. But Oregon came on the stage of recorded history in the great international drama of the fifteenth to eighteenth centuries, which we call in history the "rise of the national state"—or, if you will, the "commercial revolution," the "age of discovery and exploration," or the period of the "rise of capitalism."

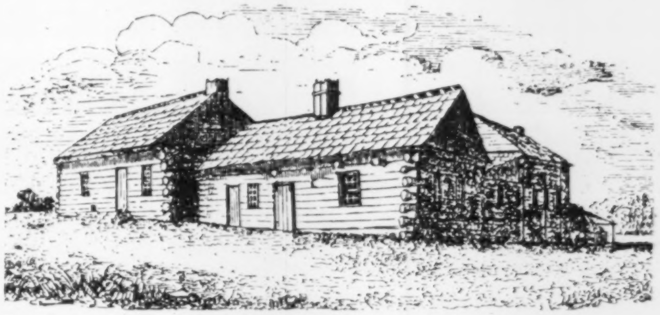
Not long before Columbus discovered America, Portuguese sailors under the guidance of Prince Henry the Navigator had discovered a new route to India by sailing south and east around Africa. The Portuguese would not tolerate the presence of the Spanish in these waters; if they wanted to go to the land of rich carpets, spices, and jewelry, they would have to go another way.

THE SEARCH FOR THE "STRAIT OF ANIAN"

The Spanish soon found out that Columbus's discovery was not the much-sought-after Cathay; it proved, instead, to be a great stumbling block in the search for a westward passage to the East. "But certainly," thought the Spanish, "we don't have to go all the way down around the strait which this man Magellan has discovered. Certainly there must be a strait cutting across this enormous land mass." The fact is, the Spanish thought so hard, and wished so much for a strait that would shorten their route to the East Indies that they actually picked out its location, gave it a name (they called it the Strait of Anian) and put it on their maps. Here, if only the entrance could be found, ships might sail through from ocean to ocean without hindrance of any kind. And thus it was that the Spaniards (among them such famous men as Ulloa, Cabrillo, and Viscaíno) in search of the Straight of Anian along the shores of the Pacific became the first white men to sight the Oregon coast. If it had not been for the mythical strait of Anian, the discovery of this region would have been long delayed.

The Spanish were not daunted by their failure to find the passage. They would trade with the East anyway. Already by the middle of the sixteenth century their colonies stretched across Mexico to Pacific waters. On the Pacific coast they would establish a port, build ships, and send them across the western ocean to far-off Cathay.

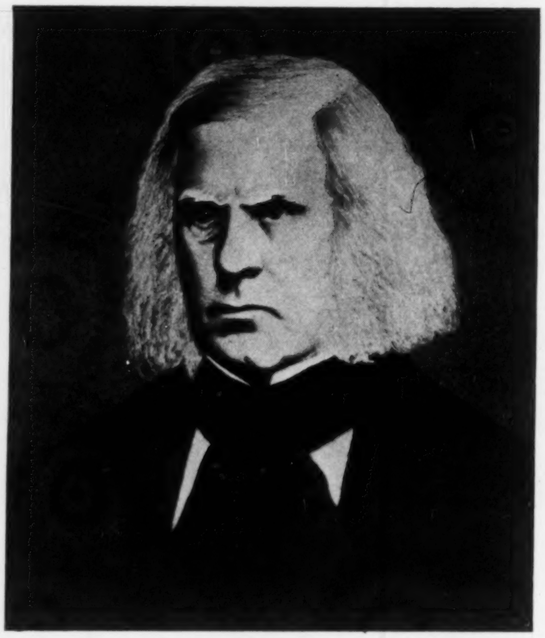
In 1565 Miguel Lopez de Legaspi made his way across the Pacific to the Philippines in a 500-ton tub. His problem then, as he saw it, was to find a return route. Loading his ship with spices and other valuable goods, he set sail for Mexico On the way he soon discovered that the ocean current and prevailing winds took him northeastward. His boat followed the Aleutian Islands, came



Courtesy Nellie B. Pipes, Secretary Oregon Historical Society

Forerunner of the First Permanent Settlement in the Oregon Country

The Mission House Built in 1834 by the Methodist Missionary, Jason Lee, Ten Miles North of Salem close to the Oregon coast, and then turned south to its home port. Thus it was that the great circle route was established—a line followed by ships to this day. And thus it was that Spain established a regular trade route between Mexico and the Philippines, a route which yielded much information about the North Pacific coast.



Courtesy Nellie B. Pipes, Secretary Oregon Historical Society

AN "UNOFFICIAL KING" OF FUR-TRADING DAYS
Dr. John McLoughlin, Chief Factor of the Hudson's Bay Company in Oregon

BUCCANEERS IN THE PACIFIC

This fat trade by the Manila galleons could not long go on undisturbed. And at this point that well-known English buccaneer, Sir Francis Drake, enters the picture. Drake knew about the richly laden Spanish vessels which came from the Philippines and he was determined to prey upon them. Reaching the Pacific coast in 1578 with his ship *The Golden Hind* he proceeded northward, looting as he went, looking for and preying upon the Spanish galleons. The fact is that his ship became so laden with riches that he feared to return via the Strait of Magellan and for that reason went north to the Oregon coast in search of a northwest passage which would take him directly home. Somewhere between the California line and the present Canadian boundary, Drake turned west, went around the world, and returned safely home, to be knighted by good Queen Bess.

It was not until the close of the Seven Years War that there was a renewed interest in the North Pacific. At that time the Spanish started to work their way into California and to lay claim to the country as far north as Nootka Sound. The Russians, by virtue of the discoveries by Vitus Bering and the subsequent establishment of the fur trade in Alaska, became interested in the Oregon country. But it was the British who became most active here.

Through the voyages of Captains Cook and Vancouver, minute exploration of the Oregon coast was made. It was only by chance that Vancouver failed to discover the Columbia River, an honor which was to go to Captain Gray, an American trader. Gray, in 1792, entered the mouth of the Columbia and sailed up the river for a distance of 25 miles. Vancouver later heard about this and followed up Gray's discovery, going up the river as far as the mouth of the Willamette. His men, in fact, ascended the Willamette as far as Portland. Thus it was (and, of course, for other reasons too) that both England and the United States could lay claim to the Oregon territory.

THE PAGEANT OF WESTERN MIGRATION

Professor Frederick Jackson Turner once observed that the settlement of our great western country could be likened to a massive pageant. If, during the days following the American Revolution a man had stood at Cumberland Gap, which opens into Kentucky, he would have seen passing before him, first, the Indian followed by the explorer; then the explorer followed by the fur trader; the fur trader by the settler; and finally, the settler followed by the business man. A hundred years later, observes Turner, one could have stood in the South Pass in Wyoming and seen the same pageant of civilization marching west toward the Pacific.

How truly this analogy fits the history of Oregon! In the slow development of the Oregon country we have already noted the rôle of the Indian and the explorer. Here as elsewhere, the fur trader was next on the scene.

"Fur trade" in Oregon calls to mind at once two famous organizations—the Pacific Fur Company and the Hudson's Bay Company. The former, under the leadership of John Jacob Astor—the son of a German butcher—came out to the mouth of the Columbia in 1811 and there established a trading post which became the foundation for the present city of Astoria.

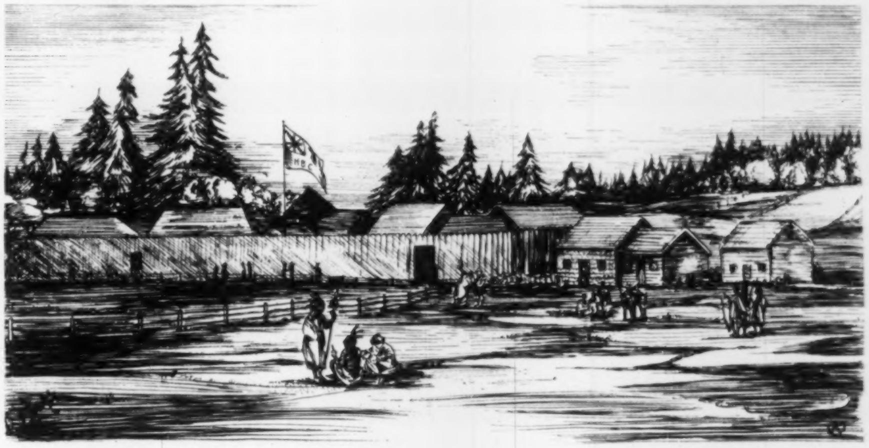
Important as this event is in Oregon's history, it does not compare with the unique rôle played by the Hudson's Bay Company—the oldest chartered company (founded in 1680) in the world today. In 1821 it merged with its Canadian rival, the North West Fur Company, and one of its first official acts following the merger was to send a chief factor (a territorial manager) out to the Columbia River area. The man selected was Dr. John McLoughlin, who was destined to be a great power—the unofficial king, one might say, of Oregon for two decades.

THE REIGN OF JOHN MCLOUGHLIN

This tall, white-headed eagle, a man with exceptional administrative ability and possessed of a warm and generous nature, came to Oregon in 1825 to take over his post. The Doctor did not think the mouth of the Columbia suitable for his headquarters and therefore returned up the river to a point about ten miles north of what is now Portland, and there he built a fort and named it Fort Vancouver. Here around the fort he cleared 300 acres of land, established a farm, and carried on the fur trading activities of the Hudson's Bay Company. Under McLoughlin's leadership, traders—about a thousand of them—combed the entire Oregon country for furs. They penetrated deep down into California, established posts under McLoughlin's rule at Stockton and San Francisco. The Californians did not like this Oregon domination, if we are to believe a letter written in 1841, which stated that "the Hudson's Bay Company is playing the devil with California cattle if not with California itself," and added that "about 120 hunters, well armed and disciplined, are now in the Tulares, and forty or fifty came as passengers in the bark and proceeded from Monterey to Tulares." But the Californians owe much to Oregon for the early exploration of the northern part of their state.

At his fort Dr. McLoughlin ruled like a patronizing medieval baron. He imposed absolute obedience upon his hundreds of employees; he and his half-breed Indian wife presided over many a gay social function to the calming strains of Scottish bagpipes inside the stockaded walls; and while the Doctor had no authority over the lives of men, on at least one occasion he tried, convicted, and hanged with appropriate ceremony an Indian who had committed murder. On other occasions he sent out punitive expeditions to convince the Indians that the Hudson's Bay Company ruled the Oregon country.

McLoughlin was the law of Oregon for many years, but with the opening of the forties he saw the handwriting on the wall. The United States and Great Britain had a treaty of joint occupation of the Oregon country. They could not agree on ownership, since both had good claims to it. Powerful as were the British interests as represented by the Hudson's Bay Company, they could not withstand the great tide of Americans which came here to make their homes between the years 1836 and 1846, and the Doctor did not oppose the Americans since he knew what the inevitiable outcome would be.



Courtesy Nellie B. Pipes, Secretary Oregon Historical Society

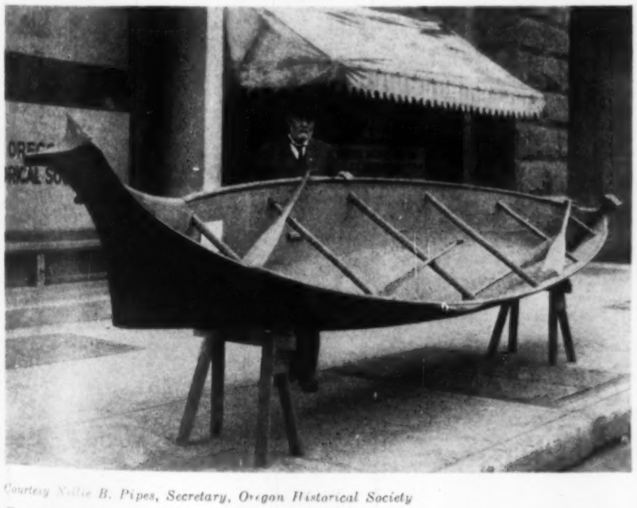
Fort Vancouver in 1845—Headquarters of the Hudson's Bay Company in Oregon, near the Present Site of Vancouver, Wash.

AMERICAN PIONEERS

First came Nathaniel Wyeth, an American trader, with Jason Lee, a missionary. Lee established a mission near Salem, to which came many settlers to make their homes. Then exactly a century ago, came Dr. Marcus Whitman to establish a mission near the mouth of the Snake River. Partly through his influence came the Great Migration of 1843, when at least a thousand settlers made the long, arduous trek along the Oregon Trail, over the Great American Desert, to the Willamette Valley. In 1844 the American people elected James K. Polk president on "54–40 or Fight," and we settled at 49.

The American people have exhibited, throughout their history, a peculiar genius for taking matters into their own hands. If settlement went in advance of government, did that bother the frontiersman? No. One recalls what happened in the trans-Alleghany settlements during the last years of the eighteenth century. No territorial government controlled those early wanderers who went through Cumberland Gap and settled on the upper reaches of the Tennessee River. But that did not concern these people; they established their own government.

So, too, with Oregon. When the American settlers became numerous in this country in the early forties, and when these settlers were determined no longer to recognize the authority of the Hudson's Bay Company, what did they do? Rather than wait for the United States to establish a territorial government for them, they decided to establish their own provisional government and wait for incorporation under the constitution of the United States. At Champoeg, not far up the Willamette Valley, "men gathered in May 1843, to determine whether they would choose government under the American constitution, or government under the British throne.... They took a vote, and 52 followed Joe Meek for America, and 50 voted for citizenship in the country beyond the sea." The majority ruled.



Courtesy Nellie B. Pipes, Secretary, Oregon Historical Society

Chinook Indian Canoes Like This May Have Influenced the Design of the Clipper Ships of a Later Day

In 1846, an Oregon settler by the name of James W. Marshall moved down to California, where on January 24, 1848, in the tailrace of John Sutter's mill, he discovered gold. This event affected the history of Oregon in no small degree. When news of it reached the northern territory virtually the entire male population left their wives and children to run their farms and moved on to California. They were among the first to arrive at the "diggings." Although most of them returned to Oregon, one—Peter H. Burnett—remained to become the first American governor of California.

The Gold Rush affected Oregon in other ways, too. She soon began to supply the great mass of California immigrants with cattle, lumber, fish, and other necessities of life, and the trade continued until the argonauts turned from the pursuit of gold to agriculture.

OREGON AS A PART OF THE UNION

In 1859 Oregon became a state. Since that time she has continued to reflect, in many ways, the progressive spirit of the West. The West, up until the passing of the frontier, definitely took the lead in the fight for political and social democracy. The constitution of Oregon is a fair example of progressive state government.

In 1890 the Census Bureau told us that we could no longer distinguish the frontier line. Students of history then began to ask themselves the question: Where is the West? Some have thought that the old spirit of the West—the ideals for which this section once stood—is now to be found in the once effete East. I for one do not think so. I think that the political West, the social West, the West that blazed the trail for whatever progress we have made toward democracy, is still to be identified with the geographic West.

Improving the Columbia for Navigation

Valuable Work on Tidal Section Should Be Extended Upstream to Snake River

By THOMAS M. ROBINS

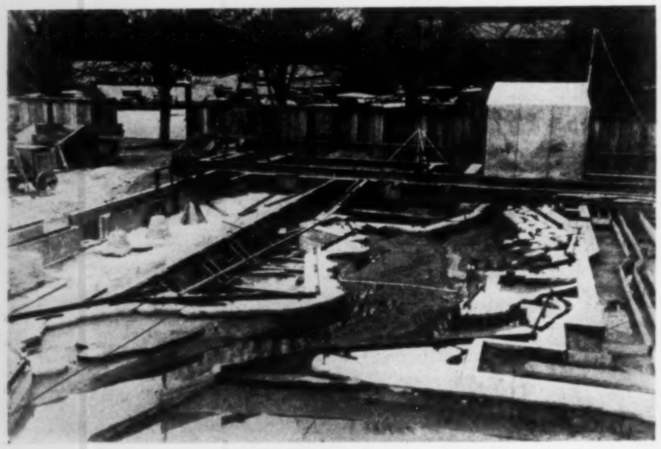
COLONEL, CORPS OF ENGINEERS; DIVISION ENGINEER, NORTH PACIFIC DIVISION, PORTLAND, ORE.

IN all the development of the Northwest the Columbia River valley has played a dominant rôle. The earliest traders utilized it as a valuable means of access, and more recent developments have created in this great basin what its enthusiastic proponents have been pleased to term the "Inland Empire." In this paper Colonel Robins confines himself to the history and future possibilities of the river as a means of transportation. Already the tidal section is improved with a 35-ft channel as far as Portland. Above the mouth of the Snake River, the economies of expenditures for navigation are problematic, but below there is a prospective freight of one and a half million tons yearly with savings up to 90 cents per ton. As the next stage in the comprehensive development, Colonel Robins suggests dredging a 27-ft channel from Vancouver to the Bonneville Dam now under construction. This instructive paper is abstracted from his address before the Construction, Power, and Waterways Divisions in joint session at Portland, Ore., on July 16, 1936.

FOR many years the Columbia River has been under improvement by the United States in the interest of navigation (Fig. 1). When the Pacific Northwest was first opened up, the rivers were the only trade routes. On the tidal section of the Columbia, seagoing traffic has been continuous since 1792 and is a vital factor in the economic life of the country. Above tidewater, railroads and highways have, for the time being, largely supplanted the river as a means of communication, but the Columbia still remains an important potential trade route to the interior.

DESCRIPTION OF THE RIVER

The Columbia River is about 1,200 miles long and drains an area of about 259,000 sq miles. It is tidal for a distance of about 140 miles above its mouth. At low stages it falls 1,284 ft between the Canadian border and tidewater (Fig. 2). Above the mouth of the Snake the average slope is 2.3 ft per mile with concentrations of drop at Kettle Falls, Grand Rapids, Rock Island, and Priest Rapids. Between the mouth of the Snake and tidewater, the average slope is 1.7 ft per mile with concentrations of fall at Celilo and Cascade rapids.



MODEL OF THE COLUMBIA RIVER ESTUARY

Study of the Lower River from Above Astoria Is Expected to Indicate Desirable Channel Development

During the period 1878–1928 the mean annual flow at The Dalles was about 146,000,000 acre-ft, equivalent to 11.75 in. over the entire drainage area. The lowest and highest flows of record were 40,000 cu ft per sec and 1,170,000 cu ft per sec, respectively. Low water in the navigable section of the Columbia usually occurs early in winter, and high water during the months of May and June. The tidal range between mean lower low water and mean higher high water at the mouth of the Columbia is about 8 ft, and at Vancouver about $2^1/_2$ ft at low river stages. Annual freshets have but little effect on depths at the mouth of the river. At Vancouver the average flood stage is about 21 ft above low water, and the highest known stage is about 33 ft above.

IMPROVED CHANNEL CONDITIONS

The entrance channel has been stabilized and improved by extensive jetty construction, begun in 1885, and now has a depth of over 40 ft at mean lower low water over a width of one-half mile. There are two converging rubble-mound jetties with their outer ends about 2 miles apart. The south jetty is about 7 miles long and the north jetty, $2^1/_2$ miles. The north jetty was completed in 1917. The superstructure of the south jetty, completed in 1914, was rebuilt with a stronger section during the period 1931–1935, and its outer end is being reinforced by filling voids in the rock with asphalt.

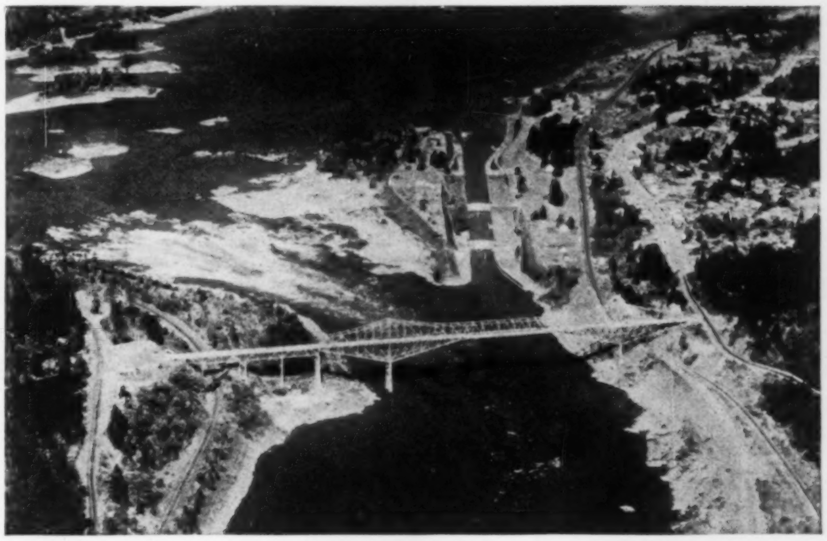
As early as 1866 some dredging was done in the river channel between Portland and the sea, and improvement has been continued from time to time. This channel now has a project depth of 35 ft and a width of 500 ft secured and maintained by an extensive system of dikes and dredging. Model tests, as illustrated by a photograph, are being carried out at the University of California for the U. S. Engineer Department with a view to determining the advisability of channel realignment and dike construction in the estuary below Harrington Point

STRENGTHENING THE SOUTH JETTY AT THE MOUTH OF THE COLUMBIA RIVER

At the Outer End of This 7-Mile Barrier, Asphalt Is Being Used to Fill Voids in the Rock

in order to reduce maintenance dredging. The tidal section of the river above Vancouver has a natural low-water depth of about 12 ft, and has so far not been improved.

On the non-tidal section of the river, canals with locks affording a depth of 8 ft at low water were built around the Cascade Rapids and The Dalles–Celilo Rapids in 1896 and 1915, respectively. The Bonneville Dam, now under construction, will drown out the old Cascade Rapids canal and lock, and the Bonneville pool will have a depth of over 30 ft as far upstream as The Dalles. The lock at Bonneville has been built large enough to accommodate ocean-going vessels. Between Celilo Falls and Kettle Falls many obstructions have been removed from the channel from time to time, increasing the depth somewhat and reducing danger to navigation. A project has recently been authorized for a channel with suitable alignment, 7 ft deep at low water and 200 ft wide, between Celilo Falls and Wallula, just below the mouth of the Snake, to be secured by rock removal and dredging. Work on this project is now in progress.



The Lock at Cascade Rapids, Which Is Soon to Be Submerged in the Bonneville Pool

Ocean-Going Vessels May Some Day Use This Waterway, Whose Present Controlling Depth Is 8 Ft

The economically interdependent area of the Pacific Northwest concerned in the development of the Columbia River has a population of about 3,000,000, of which 59 per cent is rural. There are four cities with a population of more than 100,000, three of them located on tidewater. The principal industries are agriculture, stock raising, manufacture of lumber and timber products, fishing, and mining. With the development of large blocks of cheap power at Bonneville it is expected that many new industries will be established in the lower Columbia River area.

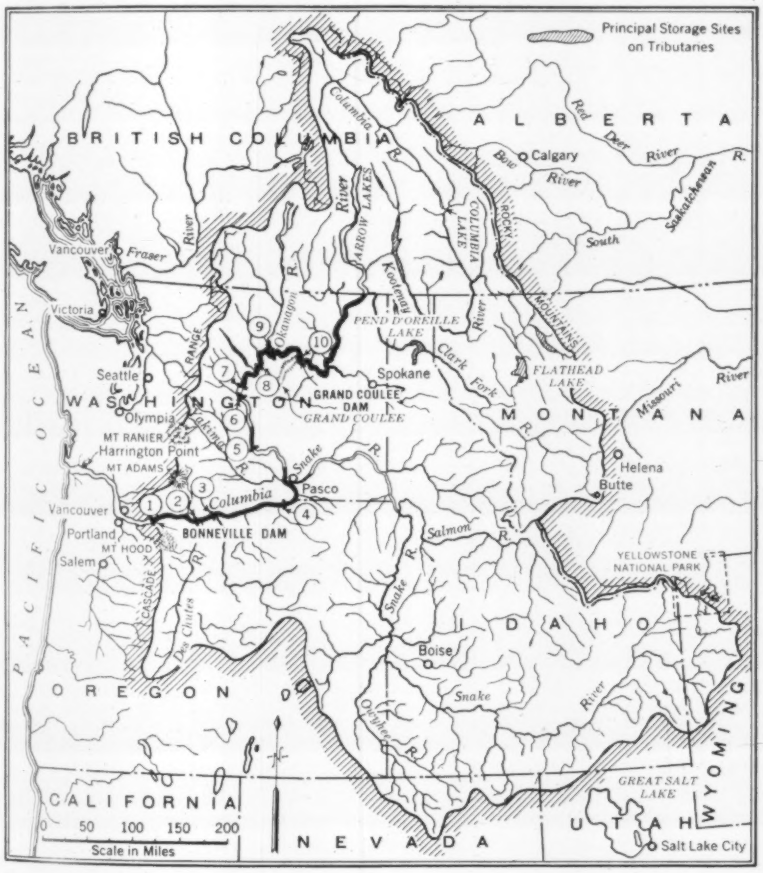

Principal Storage Sites on Tributaries
BRITISH COLUMBIA
ALBERTA
Calgary
Bow River
Red Deer River
Saskatchewan R.
South
ROCKY MOUNTAINS
COLUMBIA LAKE
Columbia R.
River
ARROW LAKES
Kootenay
River
Fraser
Vancouver
Victoria
RANGE
Okanagon R.
PEND D'OREILLE LAKE
Clark Fork R.
FLATHEAD LAKE
Missouri River
Seattle
WASHINGTON
Olympia
Spokane
GRAND COULEE DAM
GRAND COULEE
MONTANA
Helena
Butte
MT RANIER
Harrington Point
MT ADAMS
Yakima R.
Snake R.
Pasco
Columbia
Vancouver
Portland
BONNEVILLE DAM
MT HOOD
Salem
CASCADE
Des Chutes R.
Salmon R.
Snake R.
YELLOWSTONE NATIONAL PARK
IDAHO
Boise
Snake
River
Owyhee R.
PACIFIC OCEAN
OREGON
CALIFORNIA
NEVADA
UTAH
WYOMING
GREAT SALT LAKE
Salt Lake City
0 50 100 150 200
Scale in Miles
1
2
3
4
5
6
7
8
9
10

Fig. 1. Lower Reaches of the Columbia, Showing Current and Proposed Developments Affecting Navigation, Power, and Irrigation

(1) Bonneville, (2) The Dalles, (3) John Day, (4) Umatilla, (5) Priest Rapids, (6) Rock Island, (7) Rocky Reach, (8) Chelan, (9) Foster Creek, (10) Grand Coulee (5,028,000 Acre-Ft Usable Storage)

Four transcontinental railways traverse the Columbia basin and converge to tidewater at Portland. In general, excellent trunk highways follow the routes of the main railway lines. Adequate modern terminal and transfer facilities exist at the various ports along the tidal section of the river and are being constructed at The Dalles. On the non-tidal section of the river above The Dalles there are a few small wharves, but no facilities for the transfer of freight between rail and water. Freight for river movement has generally been hauled by wagon or truck to the river bank and transferred without the use of mechanical devices for loading or unloading. The construction of adequate terminal and transfer facilities on the upper Columbia is a prerequisite to the development of profitable water-borne commerce above The Dalles.

PRESENT AND POTENTIAL COMMERCE

Over 50 ocean steamship lines operate vessels to and from Portland, Vancouver, and other lower Columbia River ports. The ocean-going commerce amounts yearly to over 6,000,000 tons, valued at more than $300,000,000. In addition, river vessels on the tidal section of the river handle each year about 2,000,000 tons of freight and 4,000,000 tons of rafted logs and piling. In the old days the non-tidal section was navigated by many stern-wheel packet boats, but the tonnage on this stretch of the river has always been relatively small. During the period 1920–1932, regular boat service was practically discontinued. It was restored in 1933, and the Cascades Canal is now handling on the average about 85,000 tons a year, valued at over $1,500,000.

Above the mouth of the Snake, conditions on the Columbia are not favorable to the future development of any considerable amount of water-borne commerce. The topography does not lend itself to the movement of freight between farms and the river bank, and the tributary area enjoys a Puget Sound rail differential which discourages shipments by river to Portland for export. If this section of the Columbia were fully improved in accordance with modern standards, the reasonably prospective commerce is estimated at not more than 250,000 tons per annum, with resulting savings in transportation costs that are small and more or less indeterminate.

In the non-tidal section of the Columbia below the Snake, the situation is different. There is a large and relatively expensive rail movement of freight parallel to the river in and out of the tributary area. A large percentage of the outbound freight is wheat and of the inbound freight, petroleum products. Studies made in this connection show that it is not unreasonable to estimate the prospective commerce on an improved river between The Dalles and the mouth of the Snake at 1,500,000 tons per year. Completion of open river work now in progress between Celilo Falls and Wallula will make possible a saving in transportation costs estimated at about 30 cents per ton. If this stretch of the river were improved by locks and dams, the saving in transportation costs would be about 90 cents per ton.

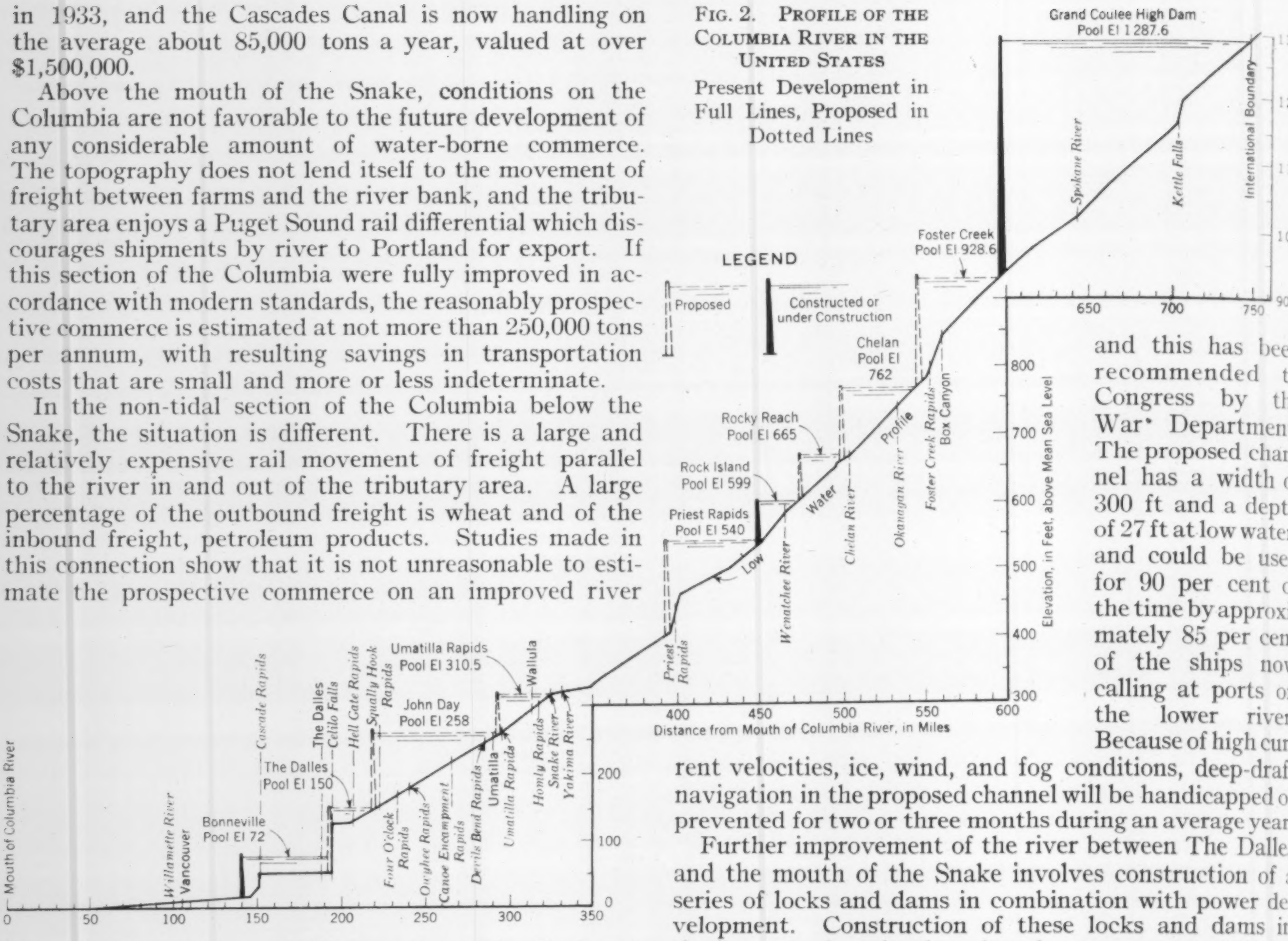


FIG. 2. PROFILE OF THE COLUMBIA RIVER IN THE UNITED STATES

Present Development in Full Lines, Proposed in Dotted Lines

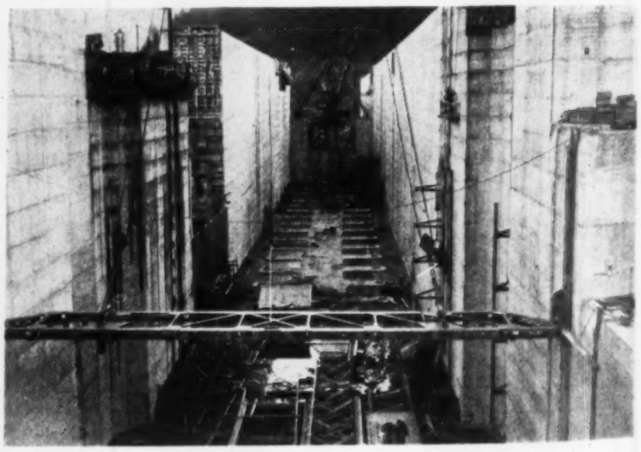
The reasonably prospective commerce for a ship channel between Vancouver and The Dalles is estimated at about 2,300,000 tons per annum, taking into account the shipment of raw materials and finished products to and from new industries that can be expected to locate along the channel on account of the availability of large blocks of cheap power from the Bonneville Dam. The saving in transportation costs that would result from the extension of ocean-going navigation to The Dalles is estimated at 40 cents per ton.

FURTHER IMPROVEMENT

That part of the Columbia River which is worthy of consideration at this time with a view to further improvement in the interest of navigation extends from Vancouver to the mouth of the Snake River. In the tidal section of the river below Vancouver, the existing through channel is adequate for present and reasonably prospective commerce, and the problem is one of maintenance with some development of auxiliary channels. Above the mouth of the Snake the development of a worth-while commerce on an improved river does not now seem possible.

Dredging of a ship channel between Vancouver and Bonneville, which will permit ocean-going vessels to reach The Dalles, appears to be the next step that should be taken in the development of the Columbia River, and this has been recommended to Congress by the War Department. The proposed channel has a width of 300 ft and a depth of 27 ft at low water, and could be used for 90 per cent of the time by approximately 85 per cent of the ships now calling at ports on the lower river. Because of high current velocities, ice, wind, and fog conditions, deep-draft navigation in the proposed channel will be handicapped or prevented for two or three months during an average year.

Further improvement of the river between The Dalles and the mouth of the Snake involves construction of a series of locks and dams in combination with power development. Construction of these locks and dams in the interest of navigation alone is not now economically justified. It will not be practicable to develop more power on the Columbia River below the Snake until the market can absorb the large amount of surplus energy from the Bonneville project. Accordingly it is impossible to say when further improvement above The Dalles should be undertaken. The best locations for the dams, when the time comes to build them, as outlined in the official reports of the War Department to date, are shown in Fig. 2. Studies are now in progress to determine what modifications should be made in this plan for ultimate development.



THE SHIP LOCK, AT BONNEVILLE, OF UNPRECEDENTED LIFT, REQUIRED WALLS 102 FT HIGH

The Chamber Was Nearly Completed When This View Was Taken Late in 1935

Construction Plant at Grand Coulee Dam

Describing Large-Scale Operations for Cofferdam, Excavation, and Aggregate Production

By C. D. Riddle

Associate Member American Society of Civil Engineers
Chief Engineer, Mason-Walsh-Atkinson-Kier Company, Mason City, Wash.

PROBLEMS faced in the construction of the Grand Coulee Dam are unusual in their order of magnitude. The diversion and control of the Columbia River, the removal of fifteen million yards of common excavation and one million yards of rock, the placing of four and a half million yards of concrete, and a multitude of incidental operations, all to be completed within a period of four years, made new demands for speed, capacity, and reliability in construction equipment. That the plant and methods evolved have been so successful is a credit to the resourcefulness of engineers, contractors, and machinery manufacturers. New possibilities in the handling of large jobs are opened up by the experiences here recounted, which cover the building of the cellular cofferdam, the excavation with its 6,000-ft belt conveyor, and the preparation of aggregates. Discussion of important problems in the mixing and placing of concrete is reserved for possible later treatment. This paper is abstracted from that presented on July 16, 1936, before the joint session of the Construction, Power, and Waterways Divisions at the Portland Convention.

In working out the construction problems presented on such a vast scale at Grand Coulee Dam, no startling novelties have been attempted. On the contrary, the selection of tools and methods was based on proven experience. In many respects it was necessary to push forward into new ranges of capacity and performance in order to meet the requirements. This was particularly true of the use of belt conveyors, which in one way or another contributed to the solution of every major problem involved except the rock excavation.

Foremost among the natural conditions to be contended with is the characteristic behavior of the Columbia River at the site of the dam. Deriving the principal part of its runoff from snowfall in the Canadian Rockies, the annual flow cycles correspond remarkably. The flow in the midwinter months ranges from 30,000 to 50,000 cu ft per sec, with rare exceptions as high as 100,000. Even in the period of the peak flows, where the greatest variations occur, the range is unusually narrow, both as to time and extent of the peak. In 80 per cent of the years of record the peak occurred in the month of June, the flow ranging from 252,000 to 480,000 cu ft per sec with an average of 365,000. This condition afforded opportunity for scheduling the critical operations of river control in the low-water months with reasonable confidence. It also imposed the hazard that failure to accomplish any one of several vital objectives would result in the inevitable loss of a year's time.

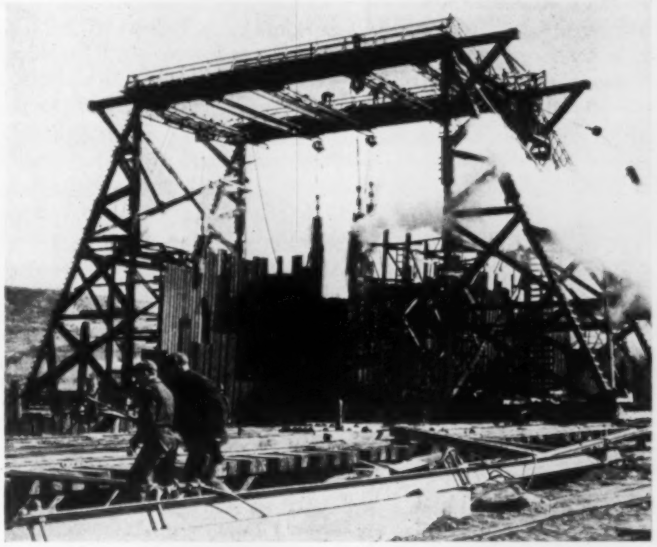
PROVIDING RIVER DIVERSION

The plan for stream control contemplates building the two ends of the dam behind cofferdams located approximately at the low-water contour. The west, or left-bank cofferdam—the Columbia here flows north—encloses the west power house and 500 ft of the spillway, thus allowing room for temporary water passages through this section for diversion of the river when the main channel is closed by the east or cross-river cofferdam in the late fall of 1936. This first unit was started immediately and finished before the high water of May 1935.

Certain critical factors influenced the design of the cofferdams. The mean low-water level may be assumed at El. 940; the high water, corresponding to a flow of 500,000 cu ft per sec, at El. 985; and the general level of bedrock at El. 875. Thus for full protection the cofferdam must withstand a head of 110 ft. At the site of the west cofferdam there was about 70 ft of overburden on the bedrock—finely ground glacial till, presumably deposited in annual layers in the quiet pool above the glacial dam which blocked the Columbia River during the period of its diversion through the Grand Coulee. The material is densely compacted in strata about an inch thick and separated by films of an extremely fine whitish substance, having the feel and appearance of talc. The tipping and foliation of these strata, as observed in test pits, showed plainly that the area had been subjected to numerous and extensive ground movements and suggested the possibility of slippage planes that might be still active.

An example of what might happen was forcibly demonstrated when the spoil from the preliminary excavation was dumped on a terrace about 1,500 ft upstream from the site of the cofferdam. Although the natural slope was quite reasonable, about 1 on 3, the loading produced a general subsidence of the terrace with an upheaval out in the stream bed. The stratified material appeared to be reasonably watertight, but in some of the test pits, lenses of free-draining sand were penetrated. This condition opened up the possibility that water under pressure might "blow" or "pipe" through one of these lenses.

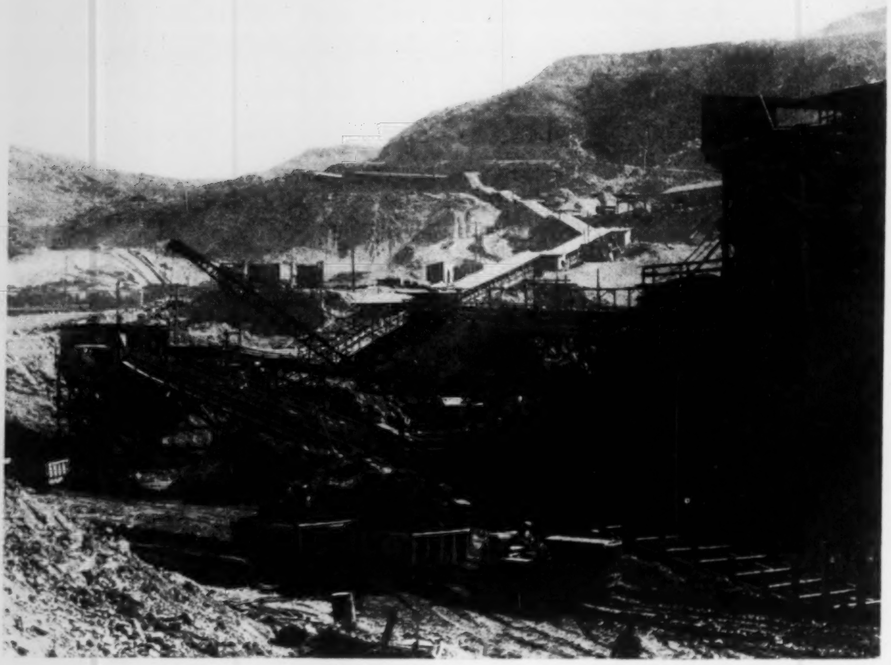
In view of all these conditions it was decided to adopt steel sheet-pile cellular construction, with the piling driven to bedrock. As an added precaution, the plan



U. S. Bureau of Reclamation

Gang Driver with Four Hammers on Trolley Hoists Successfully Used to Speed Up Construction of Cofferdam contemplated leaving a substantial berm of material inside the cofferdam during the high-water season.

The contractors were authorized to proceed with the work on September 25, 1934. As the spring rise could be expected to start in April and reach a crest in June, there remained a period of only six months—including extremely cold weather in January and February—to assemble plant, drive about 15,000 tons of piling, and place about 400,000 cu yd of fill in the west cofferdam. In selecting the plant, the first requisite was immediate availability. This accounts, in part, for the wide variety of units employed. The list included three stiff-leg derricks, three long-boom skid rigs, two steam revolving cranes on track mounting, four electric whirleys with 110-ft booms on gantry mounting, two long-boom crawler cranes, and several smaller supporting units. The driving was done with type,-9B hammers, of which there were 26 on the job. The hammers were fitted with attachments to straddle and drive two piles at a time.



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EXCAVATION DETAILS, WEST COFFERDAM

Surge Feeder at Right Stands on an Island; New Surge Feeder at Left Operates on Lower Level with Two Tributaries Installed. The Main Disposal Line Runs Up the Hill in the Background

SCHEMES TO SAVE TIME

It soon developed that it would not be possible to drive the piles to rock, but in view of the uncertainties of the ground it was thought advisable to drive to refusal. The hard driving slowed up progress to such an extent that the whole schedule was jeopardized. It was literally impossible to put any more boom units into the available space; it became necessary to develop some means of working several hammers on one unit. So a wood frame gantry was built supporting two steel girder beams on a 70-ft span across the cells. Four I-beam trolley cranes were suspended on the lower flanges of the beams, each crane carrying a hammer. The piling was strung and seated with boom rigs; then the gantry was advanced for the driving. For an improvised rig it proved to be an outstanding success. The first piling was driven on January 1, 1935, and the whole was completed on March 31, 1935.

Approach of high water made it imperative that the cells be filled in the shortest possible time. So a 48-in. shuttle conveyor belt 800 ft long was installed on a track parallel to, and about 150 ft away from the cells. The belt could be operated in either direction, and the entire assembly could be moved along the track. At each end of the belt there was a 200-ft steel boom carrying a 36-in. conveyor belt. Each boom was supported at its outer quarter point on a portable tower.

Thus with the combined flexibility of the boom and shuttle it was possible to deliver fill to any desired point along the 2,000 ft of cofferdam. The material was brought from the upper levels of the excavation on the general conveyor disposal system and diverted over a cross belt to the shuttle belt. Approximately 400,000 cu yd was placed in the cells and berms between February 22 and April 15.

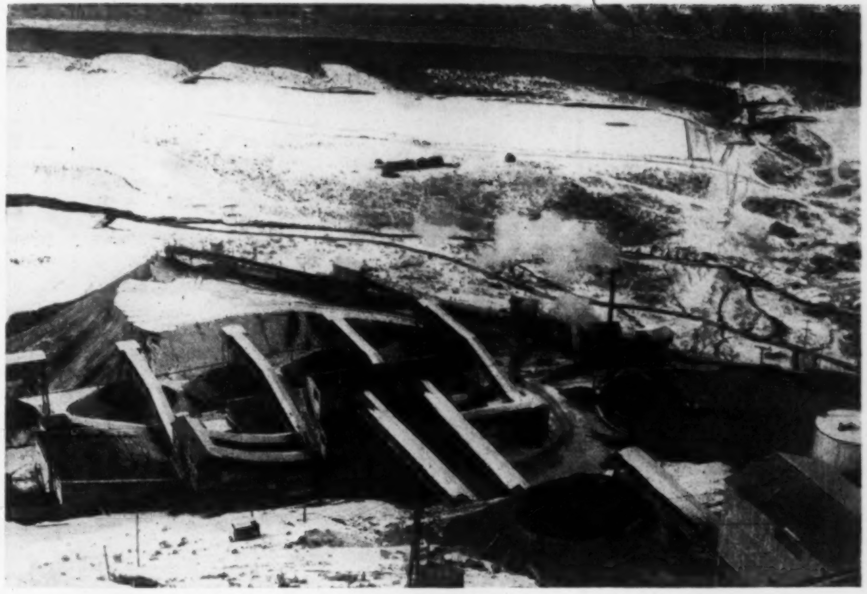
EARTH HANDLING ON A HUGE SCALE

Stated in its simplest terms, the removal of the common excavation required a plant capable of loading and transporting forty to fifty thousand yards per calender day over a distance of 6,000 ft with an average rise of 425 ft. The belt conveyors used are 60 in. wide and run at 600 ft per min. As finally extended, the main disposal line contained 21 flights, each powered with a 200-hp motor.

Operating experience with this installation proved that the real problem was to load the material onto the belt in a continuous and uniformly regulated stream. To accomplish this, a "surge" feeder was installed ahead of the first flight in the main line, the location being selected for its convenience as a focal point for converging belt lines from the pit feeders. An operator stationed at the surge feeder had the responsibility of keeping the main line loaded. He had control of the operation of the pit feeders and could shut down one or more at will.

Feeders were of the steel apron type, 5 ft wide and 46 ft long, mounted in very heavy structural-steel frames. The assembly was designed for convenience in moving the entire unit from one location to another without dismantling. Power was applied with a 75-hp motor through suitable reduction gearing to drive the apron at a speed of 40 ft per min. The hoppers above the aprons were 40 ft long and about 7 ft high. To prevent the material from packing in the hopper, the skirts were slightly tapered, and relieving tables were built across the opening, each slightly higher than the last, so that the load on the apron moved toward the discharge through an expanding bore. After these features were installed, no further difficulties were experienced in overloading the mechanism.

Operation during the first few days was very troublesome, largely because of damage to the equipment caused by boulders which could not be sorted out at the loading point. It was immediately evident that some satisfactory means of eliminating these boulders would have to be devised. After numerous trials, heavy grizzly frames with 12-in. spaces between bars were finally installed over each of the receiving hoppers. The grizzly surface



General View of the Screening Plant

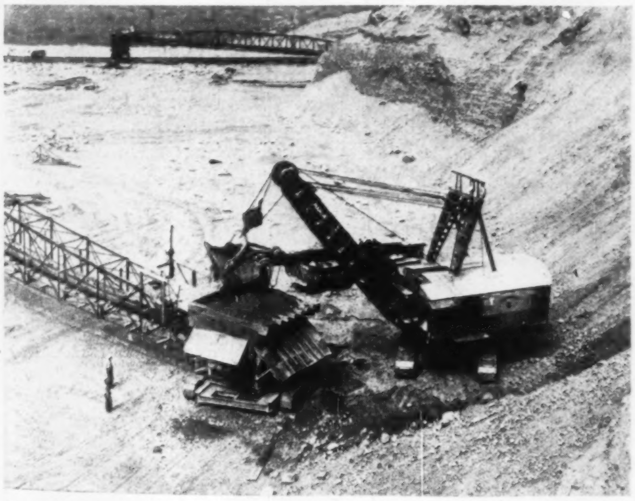
Crusher Building in Right Foreground Discharging Material to Balancing Pile; Finished Aggregates in Stock Piles Over Tunnel at Rear of Plant; Waste Sand Piles in Background; Clarifiers to the Right; Sand Classifiers in Shed at Left

was level and the construction was so strong that a heavy-duty bulldozer could drive across, sweeping the rejects aside, to be picked up and trucked out separately. As the cut reached the lower levels, it was found that the material would come out of the dippers in hard lumps too large to go through the grizzly openings. These were broken up simply by driving the tractors over them, applying the power first to one crawler belt and then to the other. This was hard on the "cats" but very effective.

Earth was excavated with electric shovels and loaded into tractor-drawn, side-dumping wagons adapted for heavy-duty, short-haul work. Two types of wagon were employed, one with a 10-cu yd body on tractor-wheel mountings hauled in trains of two wagons; the other with a 25-cu yd body, on 16 low-pressure pneumatic tires. In addition to the tractor-drawn wagons it was found expedient to use standard dump trucks for long hauls, also tractor trucks for steep grades and close corners. Between December 1934 and August 1935, approximately 8,000,000 cu yd was moved over the belt. The best month was June 1935, with 1,098,000 cu yd. In the best 24-hour day, 50,708 cu yd was moved.

TO SECURE PROPER AGGREGATES

Concrete aggregates come from the Brett deposit about a mile north of the east abutment and nearly a thousand feet above the river. As might be expected in a deposit of glacial origin, the material is of splendid quality but the gradation of the pit is erratic. Operations to date indicate, as an overall average, that approximately 2.2 cu yd of pit run is needed for 1 cu yd of concrete. The gravel is reasonably well balanced in gradation from $^{3}/_{16}$ in. to 6 in., and the proportions of the mix can be readily adjusted to utilize the entire yield with no crushing required except to reduce that over 6 in. The excess is entirely in the sand and, as a further complication, the natural sand gradation is widely variable from one part of the pit to another. Hence three problems of plant design were paramount: First, to provide low-cost handling for the enormous tonnage; second, to select from the widely variable pit run a concrete sand of uniform gradation which would meet the specified requirements; and third, to dispose of a waste tonnage considerably larger than the usable product.



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In the Aggregate Pit a 4-Cu Yd Electric Shovel Loads a Hopper at End of 200-Ft Radial Boom Conveyor

In the Background Appears a Similar Unit with the Pivot Supported on a Car Over Lateral Conveyor

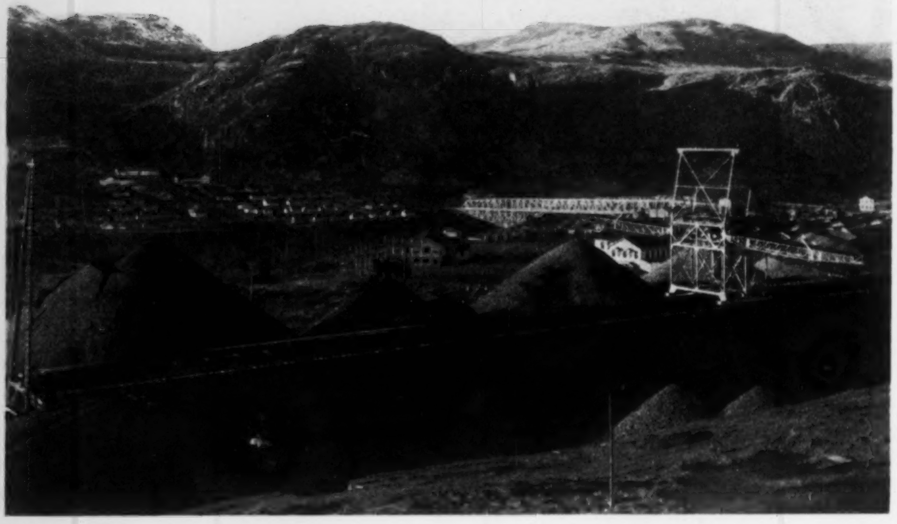
The area to be operated is roughly 1,500 ft wide by 3,300 ft long, with an average cut of 80 ft. The pit excavation is handled by belt conveyors from the shovels to the raw stock pile with no intermediate haulage. Each shovel loads directly into a hopper mounted on a crawler frame, which also supports the outer end of a 200-ft steel boom carrying a 42-in. conveyor belt. A vibrating feeder regulates the flow from the hopper to the belt. At its discharge end, the boom is pivoted on a car which straddles the pit conveyor. Full flexibility is provided in the support of the boom at either end, by means of turntables and hinges as well as a short range of radial travel. Thus the assembly can be swung around the pivot car to follow the shovel through a semicircular cut about 450 ft in diameter (including the reach of the shovel) and then moved ahead entire for the next cut. Remarkably high shovel output is being obtained by taking thin cuts and keeping the hopper in the correct position for short-swing loading.

The main pit conveyor discharges into a raw stock pile which lies in a natural draw on the west slope of the deposit. By building a reinforced-concrete feeder gallery in the bottom of the draw at El. 1,600, three purposes were accomplished here. First, the material is lowered 240 ft from the pit to the plant; second, ample live storage of raw stock is provided; and third, the production of two shovels working in different parts of the pit is blended, resulting in a more uniform feed to the plant.

In the processing the first step is the conventional arrangement of two 60-in. by 22-ft revolving scalpers with 7-in. openings, discharging rejects to a 20-in. gyratory crusher for reduction to less than 6 in. The produce is dropped into a balancing pile, with a live storage of about two hours of plant demand. This is in effect a surge storage to provide operating leeway ahead of the screening plant.

AGGREGATES SORTED INTO FOUR SIZES

In the screening plant, the gravel is separated from the sand and graded into four sizes designated as "cobble," "coarse," "medium," and "fine." Twelve heavy-duty double-deck vibrating screens are arranged in four parallel batteries of three screens each. The first unit in each battery, carrying the 3-in. and $1^1/_2$-in. screens, is placed immediately above the other two so that the load is divided between them. The "medium" separation is at $^3/_4$ in., and the "fine" at $^3/_{16}$ in. Material is fed to the plant by two conveyors, each serving two screen batteries, being regulated by feeders in galleries under the balancing pile, two feeders to each belt. Any of the four batteries can be readily cut out for repairs or servicing with the minimum of interruption. Wash water is introduced in the feed ahead of the first unit and is also applied through rinsing spray nozzles to each of the screens. The graded products are lowered through stone ladders to outhaul conveyors, which carry them to their respective stock piles.



AGGREGATE STORAGE PILES, SHOWING AIRPLANE TRIPPER WITH 75-FT WING BOOMS
The Reclaiming Tunnels Are in Trenches Under the Piles

At this point, the large excess of sand necessitates a departure from the usual treatment. About two-thirds of the sand must be wasted, but the one-third retained must be of the right gradation. The obvious solution would be to use the wash water to carry the waste sand away from the plant. But, in the first place, the water supply is pumped against a 650-ft head, and a substantial power saving could be realized from its recovery for re-use; furthermore, there were evident difficulties in the confinement of a water-deposited waste pile of nearly six million yards on the property available, below the carrying gradient from the plant. The process adopted was to dewater the sand, dispose of the waste on a belt conveyor, classify and reblend the retained sand, and recover as much of the water as possible, for re-use.

Eight heavy-duty drag flights were installed in reinforced-concrete tanks. The sand settles in the silting pools and is carried up on the drags, discharging into bifurcated chutes, one loading the waste belt, the other a belt to the classifiers. Three bowl-type classifiers of 13, 16, and 25-ft diameter are installed in series; that is, the first overflows into the second, and the second into the third. The units are designed to retain and rake out all sand coarser than 20 mesh, 48 mesh, and 100 mesh, respectively. These three fractions are retained in separate stock piles long enough to allow the excess water to drain off, after which they are blended through variable-speed belt feeders to the required fineness modulus. The flexibility and effectiveness of the arrangement has been proved by the remarkable uniformity of the final product. Because of expected variations in the gradation of the feed, the classifiers were designed to handle large tonnage. For example, if the feed is too coarse, then in order to maintain capacity, an excess amount of feed must be classified and the coarse fractions discarded to balance the recovery of fines. Under operating conditions, it was found that a certain amount of hydraulic classification was taking place in the dewatering drags. By taking advantage of this, it was possible to make a rough selection of the feed to the classifiers and thus ease their burden.

On the top floor of the screen house, the electrical control of the plant is centralized. Related operations are grouped together in electrically interlocked sequences, each controlled by a master switch. For each group, the unit farthest along the flow line starts first, the others following automatically at intervals. If a motor shuts down because of trouble, all the motors ahead of it in the group are automatically stopped; all those following it continue to operate so as to clear the plant. Emergency stop buttons are placed at convenient locations. Any motor can be operated independently of sequence control, if required for test.

The graded products of the plant are transported over a 48-in. belt conveyor 5,975 ft long, running at 400 ft per min to the main storage piles located near the dam, as close to the mixing plants as the topography would permit. Materials are reclaimed from storage by belt conveyors in tunnels underneath the piles. The tunnel gates are remote-controlled by operators at the mixer-plant bins. Transportation by belt conveyor from storage piles to the east mixing plant is relatively simple, but the west plant is 4,400 ft away and on the opposite side of the river. Furthermore, it is located on a steep rock bluff where no space is available for ground storage. The 36-in. belt conveyor is carried across the river on a suspension bridge having two main spans each 1,430 ft long. In addition to the conveyor this bridge also carries the cement line to the east mixing plant.

To mix and place the concrete at Grand Coulee Dam, an elaborate and extensive plant has been developed. It involves considerations to which a paper of such limited scope cannot do justice and which deserve separate treatment. In preparing this outline of the general scheme of plant layout, it has been necessary to confine the description to the principal features. An almost unlimited amount of space could be devoted to interesting details. Mistakes have been made and corrected, but operating experience has proved the soundness of the general plan of attack.

Oregon Roads and Bridges Advance

Some Forward-Looking Developments in Design and Construction

SINCE 1917, the progress of the Oregon state highway system has been rapid. Master maps have now been prepared, which show the relative importance of every road in the state and indicate in each case the degree of improvement contemplated. Avoiding danger of early obsolescence, the main traffic arteries are being designed for speeds of from 60 to 100 miles per hour, depending upon the topography of the country traversed. In the first of the following three articles, abstracted from papers delivered on July 16, 1936, before the Highway and Structural Divisions at the Society's Portland Convention, Mr. Baldock discusses the principal elements governing the highway department's selection of design standards.

Forming an important part of the state system, the Oregon Coast Highway extends all the way from Astoria on the northern boundary to the California line, a distance of about 400 miles. Until the past summer it has been necessary for motor traffic to use no less than five ferries to cross the various rivers and bays intervening. When it was decided to bridge these bodies of water, the state highway department made extensive studies of the comparative cost of high-level versus draw-span bridges at each site. Mr. Chase's article presents in some detail the principal design factors involved. The structures finally selected included, among others, a 1,708-ft cantilever having a main span of 793 ft; a 600-ft fixed steel arch; three concrete arches of 154 ft, 210 ft, and 154 ft, respectively; a 430-ft center-bearing swing span; and a double-leaf bascule 140 ft wide between piers.

Some of the more unusual problems met and methods used in the construction of the five coast highway bridges are described in Mr. Paxson's article. The main steel arch at Yaquina Bay was tied back during erection by cables extending over falsework towers on the permanent piers to connections with the adjacent side arches. Each cantilever arm at Coos Bay was erected without falsework, by balancing with the anchor arm, which rested upon a pier and two false bents. The deflection of the trusses at Coos Bay due to cantilever erection of the suspended span was taken care of by building each tower slightly out of plumb and jacking up the bottom chords to make the closure.

Highway Design Applied to the State System

By R. H. BALDOCK

CHIEF ENGINEER, OREGON STATE HIGHWAY COMMISSION, SALEM, ORE.

SCIENTISTS approach the study of nature's laws by two diametrically opposed methods—the telescope and the microscope. The highway engineer has been using the microscope in the study of problems relating to highway design and construction, but evidently has overlooked the importance of gaining a proper perspective through the use of the long-range telescope. During the past decade a careful study has been made of the strength of materials; the proportioning of aggregate water, and cement for concrete; and the proper proportions of asphalt and stone and the gradation of aggregate in asphaltic concrete mixtures. During late years there has been an intensive investigation of foundations and of the bearing power of soils. Little attention has been given, however, to the study of the design of state highway systems, and to the study of the many increasingly difficult traffic problems involved in this country's motor-transportation systems, which reach from the large metropolitan centers to almost every isolated hamlet.

The planning survey sponsored by the Bureau of Public Roads and carried on jointly by the federal government and the several states will attempt to inventory all roads to determine their present condition, the traffic that they carry, and the cost of improvement commensurate with reasonable expectation of use. This survey will compile factual data which should lead to correct conclusions as to the classes of roads which should be built and maintained by taxes on motor vehicles and motor fuels, in contrast to the local or land service roads which most economists believe should be cared for through property taxes.

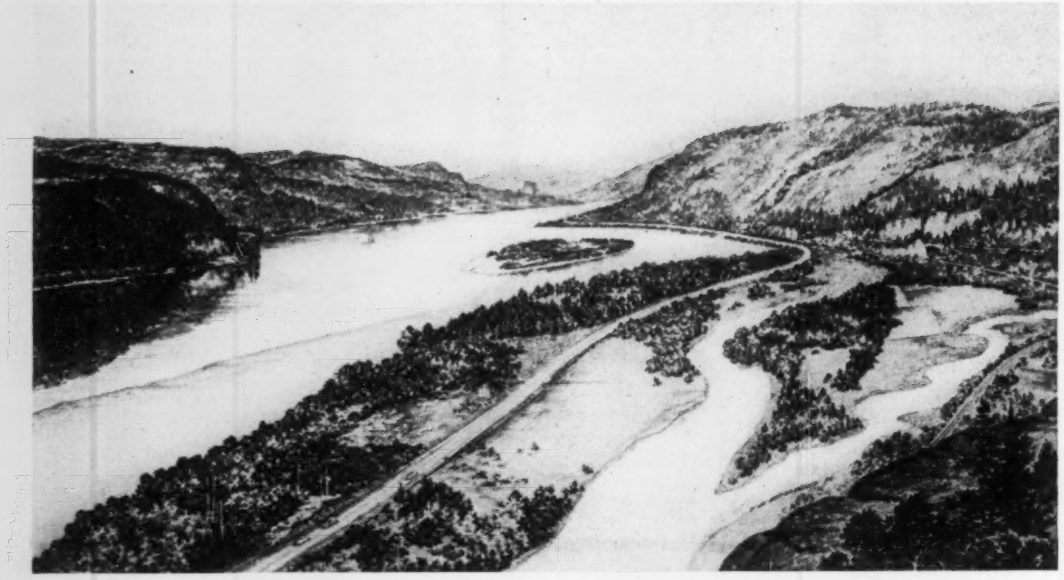
By the use of the economic yardsticks of saving in time, distance, and cost of car operation through road improvements, and in proportion to the estimated cost of such improvements, an intelligent construction program, giving projects in order of priority, can be prepared. Consideration should then be given to highway design, not only for new roads but for the reconstruction of old roads. For the most part, roads constructed a decade or more ago are now obsolete as far as the demands of modern traffic are concerned.

CAREFUL RECONNAISSANCE THE FIRST STEP

The first step in highway design in Oregon consists of a detailed reconnaissance on foot covering a wide area and investigating every possible route. This is supplemented by a study of aerial photographs. Aerial photography, now only in its infancy, will unquestionably play a tremendously important part in future mapping. Recent developments in German machines, involving the projection of contours with remarkable accuracy, indicate that the adoption of aerial mapping will spread rapidly during the next decade. However, a certain amount of ground work will always be necessary.

The practice in Oregon involves the use of hand instruments and the making of maps, profiles, and cost estimates of the investigated routes. Comparison with later location surveys shows that a reasonable accuracy can be secured. At least three men check up the reconnaissance studies so as to remove the possibility of individual prejudice or error. The best route is then selected and the reconnaissance data turned over to the locating engineer, who has previously received a master map prepared from detailed traffic studies showing the relative importance of the various sections of highway in the state and the degree of improvement contemplated for each.

Preservation of the beauty of the roadside should be a major factor in the design of highways. As the land-



PROPOSED NEW COLUMBIA RIVER HIGHWAY, ISLAND LOCATION AT CROWN POINT

scaping of highways properly begins with the location of the proposed road, the locating engineer works in the field with a landscape architect, particularly on the more scenic sections. In certain cases artists' sketches are prepared to depict the appearance of the road after construction. Such sketches are of value to the engineering staff and unquestionably prevent errors in location and unnecessary scarring of the terrain. They have been found extremely valuable with reference to studies of the architectural treatment of bridges, tunnel portals, and the like, and are also very informative to the public at large. Too often the engineer has failed to take the public into his confidence and to advise them of the plans for improvement.

MAXIMUM DESIGN SPEED 100 MILES PER HOUR

One of the gravest menaces to any business is the specter of obsolescence. Models of motorized units change every year, and while the obsolescence of a motor vehicle can be spread reasonably over a period of about five years, no state or commonwealth has the requisite funds to change highway models with this frequency. In Oregon of late years it has been the practice to use very high design standards in order to avoid such obsolescence. New roads are laid out with this purpose in mind, and older roads are not reconstructed until the requisite funds are available for proper modernization. A study of the economic factors relating to highway design, begun by the Oregon State Highway Department some six years ago, pointed conclusively to the necessity for a design based on a selected speed, and the proper correlation of all factors in the design to that speed. The motor user is now demanding that highways be widened and straightened to permit greater speed with less hazard. About four years ago the studies of the Highway Department were put into practice, and standards ranging in design speeds from 25 to 100 miles per hr were chosen. These standards are shown in the accompanying Table I.

The skepticism of the general public with relation to the permanency of the standards proposed today is natural since those proposed a decade or more ago are now obsolete. The answer would appear to be that previous standards were designed for low speeds at a time when the new form of transportation was in its infancy. Modern design, on the contrary, is based on speeds equal to or greater than those at which the human organism can function properly. It is possible to improve the motor vehicle even beyond this point, permitting still higher speeds, and it is likewise possible to design and construct highways that will permit the driving of motor vehicles at such speeds, but the limitations of the human nervous system would seem to be the controlling factor in design. A number of insurance companies have recently set up machines which measure the reaction time of an individual with a fair degree of accuracy. By providing for the corresponding speed as a maximum, relative permanency should be secured.

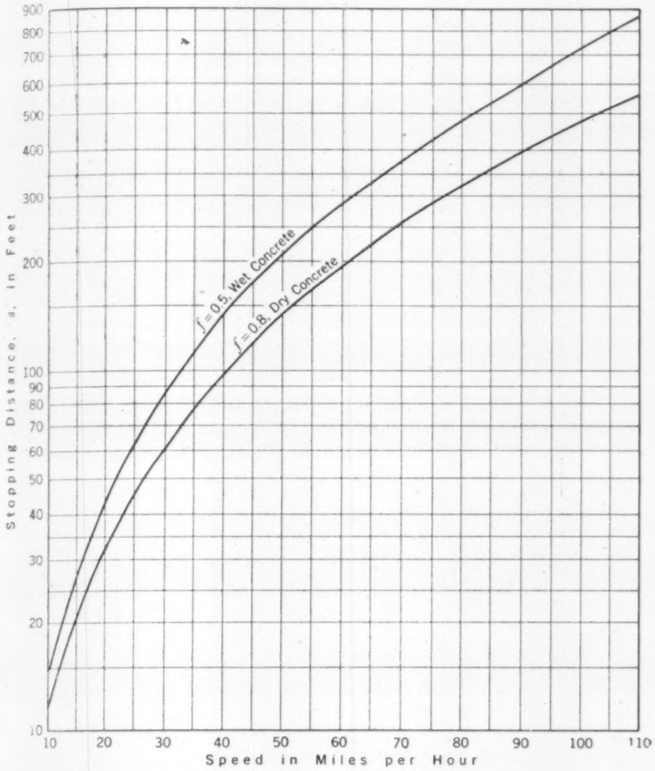
The Class A roads, or main traffic arteries, are designed for speeds ranging from 100 miles per hr in flat country to 75 miles per hr in rolling country, and 60 miles per hr in foothills and mountains. This does not mean that the Highway Department is recommending speeds up to 100 miles per hr. Good structural practice dictates that

TABLE I. SURVEY STANDARDS FOR VARIOUS CLASSES OF HIGHWAYS IN DIFFERENT TYPES OF COUNTRY

ITEM	FLAT COUNTRY							ROLLING COUNTRY							FOOTHILLS AND MOUNTAINS						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Critical or design speed, miles per hr	100	90	75	65	60	55	50	75	65	60	55	50	50	35	60	55	50	50	45	40	25
Recommended safe speed, miles per hr	65	65	65	55	50	45	40	65	55	50	45	40	40	30	50	45	40	40	35	30	20
Maximum curve, deg	2	4	6	8	10	12	16	6	8	10	12	14	16	28	10	12	14	16	20	24	56
Width of roadbed, ft	46	42	38	34	30	26	22	46	42	38	34	30	26	22	46	42	38	34	30	26	22
Maximum grade for not to exceed 3,000 ft, percentage	5	5	5	5	5	5	6	6	6	6	6	6	6	7	6	6	6	6	6	6	7
Maximum grade on long grades, percentage	5	5	5	5	5	5	6	5	5	5	6	6	6	7	5	5	5	6	6	6	7
Minimum sight distances on vertical curves, ft	1,200	1,200	1,000	800	700	600	500	1,000	800	700	600	500	500	300	700	600	500	500	400	300	200
*Minimum sight distances on horizontal curves, ft	775	550	425	350	300	250	225	450	375	325	275	250	225	150	350	325	275	250	225	175	50
Stopping distances at critical speed, ft	750	600	425	325	275	250	200	425	325	275	250	200	200	125	275	250	200	200	175	150	75
†Stopping distances at safe speed, ft	325	325	325	250	200	175	150	325	250	200	175	150	150	100	200	175	150	150	125	100	50

*Continuous curves when roadbed lies entirely within cut, with 1 on 1 slopes.
†Stopping distances on wet pavement.

structures should be designed with a factor of safety for loads so that the members will not be subjected to ultimate breaking stresses. Likewise cars designed to travel at a maximum speed of 90 to 100 miles per hr have a driving range from 60 to 70 miles per hr only, over any extended period. It would appear foolish, therefore, to neglect a factor of safety in the design of highways. Highways designed for 60 miles per hr will be found suitable for a speed of 50 miles per hr, and those designed for an overturning or critical speed of 100 miles per hr should safely carry motor vehicles at speeds ranging from 60 to 70 miles per hr.



Iowa State College Bulletin 120

Fig. 1. Relation Between Stopping Distances and Speeds on Typical Highway Surfaces

In determining the design speed for any section of highway, based on the critical or overturning speed of a motor vehicle, the salient factors that should receive consideration are stopping distance, sight distance, traction between the wheel and the pavement, superelevation, and transition curves.

FIXING STANDARDS FOR STOPPING DISTANCES

Stopping distance is a function of the braking power of the machine, which depends on the frictional resistance between the tire and the pavement. The design should not be based upon pavements covered with snow or ice, but rather upon wet pavements, as this condition prevails a great deal of the time. Judgment on the part of the driver is necessary under all conditions, and when the pavement is icy the driver should be guided accordingly.

Braking distance can be computed from the formula,

$$S = \frac{V^2}{30f}$$

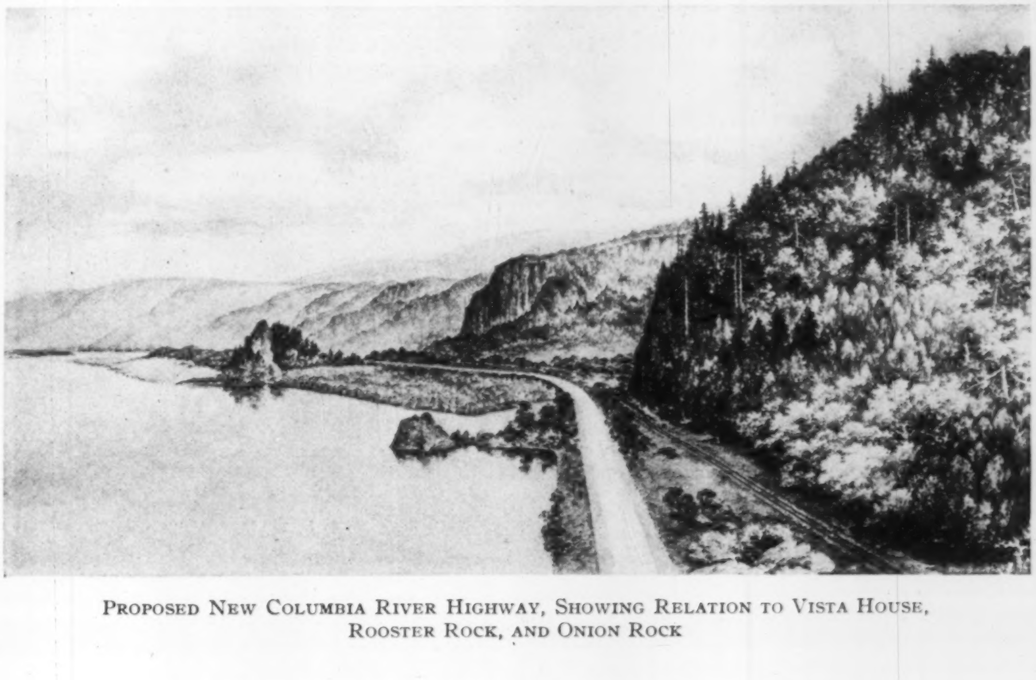
in which S = stopping distance in feet
V = velocity in miles per hour
f = coefficient of straight skid friction

Oregon standards assume a straight skid coefficient of friction for wet pavement of 0.5, which gives a stopping rate of 16.1 ft per sec per sec. This is considered the maximum rate of deceleration that is reasonably safe and comfortable. The reaction time of the driver is taken as a half second, and the formula for stopping distance then becomes

$$S = \frac{V^2}{30f} + 0.733V$$

The curves in Fig. 1, computed in accordance with this formula, show the relation between stopping distances and speeds on typical surfaces.

It is necessary, of course, to have both horizontal and vertical sight distances at least equal to, and preferably somewhat longer than, the stopping distance. The horizontal sight distance is controlled by the degree of the curve and the obstruction to vision along the inside of the curve. The most prevalent sight impairment is that caused by the bank in a cut. Vertical curves are in many respects more hazardous than horizontal curves, since the impairment to sight distance on a horizontal curve is self-evident, whereas many people are taken unawares when approaching the crest of a vertical curve. This condition is a prolific source of accidents. The vertical-curve sight distance should be equal to at least twice the stopping distance for the design speed, so as to enable each driver to see an approaching car over the top of a vertical curve.



Proposed New Columbia River Highway, Showing Relation to Vista House, Rooster Rock, and Onion Rock

Oregon standards call for a vertical sight distance of 1,200 ft on arterial highways.

The tractive resistance between the wheel and the pavement is a very important feature in modern highway design. Almost everyone recognizes the necessity for nonskid pavements. Various devices have been used to measure the skid factor, or frictional resistance. The admirable treatise on "Skidding Characteristics of Automobile Tires on Roadway Surfaces," by R. A. Moyer of Iowa State College, describes these tests in detail.

THE OREGON COAST HIGHWAY CUTS THROUGH THE WOODS NORTH OF GARDNER

When a motor vehicle moves in a horizontal curve, centrifugal force acts radially in accordance with the well-known formula,

$$F = \frac{Wv^2}{gR}$$

in which v = velocity in feet per second
W = weight of motor vehicle
g = acceleration of gravity
R = radius of curve

Centrifugal force can be eliminated for low speeds by superelevating or banking the roadway. It is not possible to superelevate sufficiently for high speeds on account of the tendency of slow vehicles to slip across the roadway, particularly when icy. Investigations made by the Highway Department conclusively indicate that the maximum superelevation should not exceed 0.13 ft per ft. Centrifugal force must, therefore, be decreased for high speeds through reduction in the degree of curvature and in particular by building nonskid pavements to resist side skidding. It has been found that nonskid pavements are even more important in overcoming centrifugal force than is superelevation. The formula for superelevation, where friction is considered, may be reduced to

$$e = \frac{0.067V^2}{R} - f$$

in which e = superelevation ratio
V = speed in miles per hour
R = radius of curvature in feet
f = coefficient of side friction or skid factor (assumed as 0.3)

In Fig. 2 are curves for critical speed, safe speed, and speed for which the standard superelevation gives full compensation. The term s in the formulas represents the superelevation of the main curve in feet per foot of roadway width, while a, the factor of safety, is given a value of 1.5.

SPIRALS OF AMPLE LENGTH PROVIDED

Transition curves or spirals are desirable to reduce centrifugal acceleration which is suddenly applied at the point of curve. The necessity for their use becomes greater with the speed, since centrifugal acceleration varies as the cube of the speed. The Highway Department has used the transition curve for about three years and the results have been very satisfactory. Royal-Dawson in his *Elements of Curve Design* proposed the following transition formula:

$$L = \frac{3.155V^3}{R}$$

wherein L = length in feet of the transition curve
V = velocity in miles per hour
R = radius of the circular curve in feet.

The acceleration toward the center of the curve is $\frac{v^2}{R}$. The rate of gain of acceleration is the acceleration divided by time, or $\frac{v^2}{R}$ divided by $\frac{L}{v}$ or $\frac{v^3}{LR}$. In other words, the rate of acceleration gain is measured in $\frac{v^3}{LR}$ units per sec per sec in a second. If C is the maximum rate of acceleration that will pass unnoticed or, in other words, not cause a decided lurch of the car, then $C = \frac{v^3}{LR}$. Royal-Dawson, in the foregoing transition formula, has assumed for C a value of 1 ft per sec per sec per sec, that is, the length of the spiral equals $\frac{v^3}{R}$, when v is in feet per second, or equals $\frac{3.155V^3}{R}$ when V is in miles per hour. Ralph A. Moyer of Iowa State College states that the rate of change of accleration may exceed 4 ft per sec per sec per sec before an actual skidding condition is reached, and that a value of 3 can be used without any decided discomfort. The latter value agrees with the Highway Department's experience, and has been adopted in its design. Using this value, the length of the transition curve becomes

$$L = \frac{1.0517V^3}{R}$$

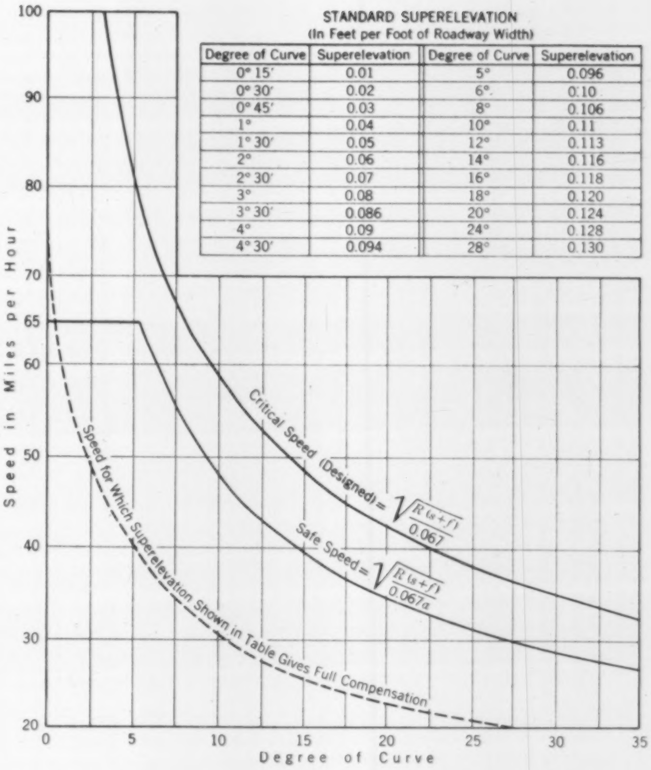
FOUNDATIONS SOLID AND WELL DRAINED

No pavement is stronger than its foundation. For many years foundations have been neglected in pavement design throughout the United States. The Roman roads, which were built with foundations ranging from 2 to 5 ft in thickness, have withstood the action of the elements and a certain amount of traffic for twenty-four centuries. Oregon is blessed with an abundant supply of road metal in the form of bar gravel, bank gravel, rock talus, and both potential and operating quarries. The Oregon practice has been to crown the subgrade slightly and place a ballast course ranging from 6 to 24 in. in thickness under all types of surfacing, including pavements of high types. The ballast course covers the entire subgrade, affording drainage to the ditch line. Special cases receive an additional treatment of underdrains. Where an entire hillside is slipping, water tunnels are constructed to drain the excess water and stabilize the ground.

Oregon has given a great deal of attention to the construction of the so-called "low-cost" road surface, mainly of the bituminous type. From investigations begun in 1923 it was soon found that roads, in order to be low-cost, must be low in maintenance cost as well as first cost. To prevent subsequent burdensome maintenance expenditures, it is therefore necessary to provide adequate drainage and proper foundations.

On the main traffic arteries, pavement lanes are made 11 ft in width. On four-lane pavements, a 4-ft neutral zone is provided to ameliorate a condition that might cause a head-on collision of opposing traffic. Plans are made for the separation of the grades of arterial roads and railways at all crossings.

Summarizing, the design practice of the Oregon State Highway Department comprises careful reconnaissance, followed by detailed location surveys, to select the routes for improvement and to build the roads selected in accordance with a standard of improvement commensurate with the amount of the traffic and the character of the terrain. While a certain amount of subsidy may at times be necessary, in general the road should earn enough revenue to amortize its construction and maintenance costs over a reasonable period of years. Highways are designed for designated speeds, and the varying factors of design are each related to the standard of speed. Careful attention is paid to drainage and foundations, and to the landscaping and preservation of the beauty of the roadside. Roads that are properly located should be reasonably permanent in character to avoid the tremendous expense of obsolescence.



STANDARD SUPERELEVATION
(In Feet per Foot of Roadway Width)

Degree of Curve	Superelevation	Degree of Curve	Superelevation
0° 15′	0.01	5°	0.096
0° 30′	0.02	6°	0.10
0° 45′	0.03	8°	0.106
1°	0.04	10°	0.11
1° 30′	0.05	12°	0.113
2°	0.06	14°	0.116
2° 30′	0.07	16°	0.118
3°	0.08	18°	0.120
3° 30′	0.086	20°	0.124
4°	0.09	24°	0.128
4° 30′	0.094	28°	0.130

FIG. 2. RELATION BETWEEN DEGREE OF CURVATURE AND SPEED, WITH STANDARDS FOR SUPERELEVATION

The development of motor transport, the solution of the engineering problems of design and the major problems of selection of highways for improvement, and the studies of taxation in proportion to road use are of interest to everyone; the correct solution of these problems is of great importance to the general welfare of our nation. As these problems are essentially of an engineering and statistical nature their solution is a fitting task for engineers.

Design of Coast Highway Bridges

By O. A. CHASE

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THE Oregon Coast Highway, which extends along the coast from Astoria to the California line, a distance of about 400 miles, was planned to serve as a commercial, a military, and a scenic route. It will eventually be a part of the proposed Pan-American Highway. The northern and southern sections were completed a number of years ago, but the central part, between the towns of Newport on the north and North Bend on the south, has only been finished within the last five years.

At Newport the highway crosses Yaquina Bay; at Waldport, Alsea Bay; at Florence, Siuslaw River; at Reedsport, Umpqua River; and at North Bend, Coos Bay. Until the past summer, ferries handled the traffic at these points. However, they were expensive, slow, and unsatisfactory, and upon completion of the highway, it became apparent that within a very few years these five bodies of water must be bridged.

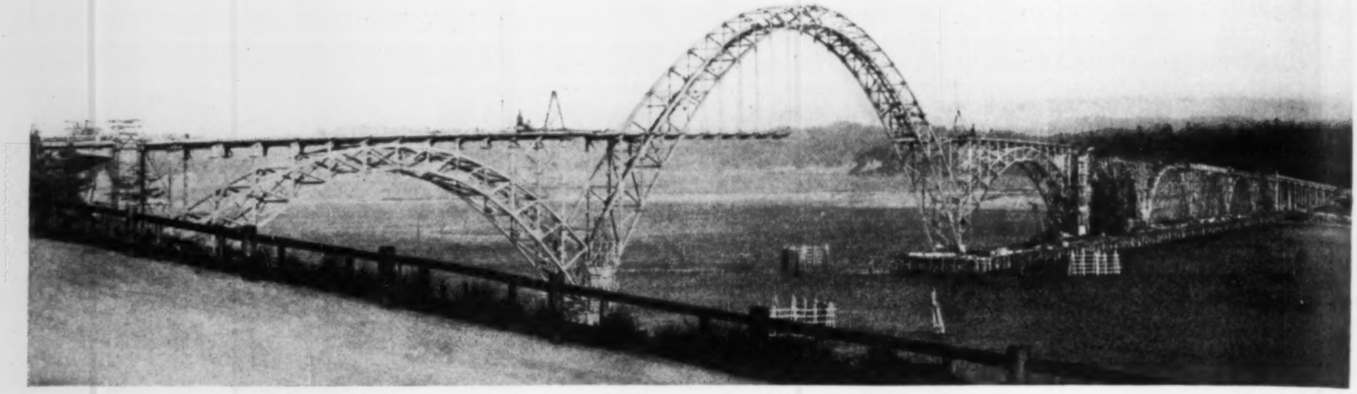
In 1933, through the Federal Emergency Administration of Public Works, a grant of 30 per cent of the cost of the five bridges was secured, while the remaining 70 per cent was to be obtained through the sale of bonds. During that summer the bridges were designed.

In what follows, it is not proposed to discuss the design of the bridges from a mathematical standpoint, but to bring out details and methods that are uncommon and to give an account of the conditions and problems peculiar to this section.

HIGH-LEVEL BRIDGES VERSUS DRAW SPANS

After locating the lines across the various channels or rivers, it was necessary to obtain from the War Department the vertical and horizontal clearances required in each case. Taking into consideration the character and amount of water traffic, lengths of spans involved, character of foundations, and costs of different types of bridges, comparative estimates were made to determine whether to build high-level or draw-span bridges.

In the choice of type, it was necessary to bear in mind that these structures would be located over salt water in



The Yaquina Bay Bridge Has a Main Span of 600 Ft
Riveting of the Upper Joints in the Three Three-Hinged Arches in the Foreground Made Them Two-Hinged

sections subject to heavy rains, fogs, sunshine, strong winds, and variable tides. Not only the original cost but also the cost of maintenance had to be considered, including the cost of operating draw spans and the disadvantages of interrupting both water and highway traffic.

At first glance, one is inclined to ask why so many types of structures were selected, but an analysis discloses that only the channel spans differ. Arches or viaducts form the approaches in all cases. Various conditions governed the selection of the channel structures. At Newport there is a high bank on the north side of the bridge site close to the channel, with sandstone available for one of the foundations—an ideal condition for a high-level span. The 600-ft arch which was chosen provides the required vertical clearance of 130 ft over a horizontal distance of 400 ft at a lower cost than either a swing-span or a cantilever bridge.

There was also a high bank at Alsea Bay on the north side, and a low flat on the south. As neither vertical nor horizontal clearances were required to be great, the necessary vertical clearance of 70 ft over a span of 200 ft was secured by use of a deck tied arch.

At the Siuslaw River the bridge would cross over a comparatively narrow channel from banks of average height, which would not permit a high-level crossing except at the expense of long, costly approaches. With only one channel available for river traffic, a double-leaf bascule was selected. This provides a horizontal clearance of 110 ft when open and 140 ft when closed, with a vertical clearance of 23 ft.

At Reedsport, the Smith and Umpqua rivers are separated by a high hill called Bolon Island. It was not practicable to build a high-level structure at this point, and since the Umpqua River has a wide channel, a swing span was selected for this part of the bridge, giving two openings each 195 ft in the clear. A long composite timber and concrete structure with a short removable span was designed for the Smith River channel.

The largest of the structures is the bridge over Coos Bay. As there are high banks on both sides and a wide channel, a high-level crossing with a 793-ft cantilever span was decided upon. This structure gives a clearance of 141 ft vertically over a horizontal distance of 338 ft. [Photographs of the Coos Bay and Alsea Bay bridges appear in the accompanying article, "Construction of Coast Highway Bridges," by G. S. Paxson.]

With the exception of the main spans, the remaining parts of all these structures and approaches are of the same type. Where it was necessary to maintain considerable vertical clearance above the water, tied arches were used; where the elevation of the road was too high to admit of the economical use of beam spans, fixed arches were adopted; and for the remaining approach work, a series of three-span continuous-type structures was selected. On account of the high cost of maintenance of steel structures along the coast, concrete was used wherever possible.

MANY ARCHES USED ON APPROACHES

The fixed arch on piling was used at Yaquina Bay, Coos Bay, and Alsea Bay. Yaquina Bay has a series of five spans, ranging from 160 to 265 ft in length, while Coos Bay has a series of six arches on one end and seven on the other, varying from 151 to 265 ft. The Alsea Bay Bridge has six 150-ft fixed arches.

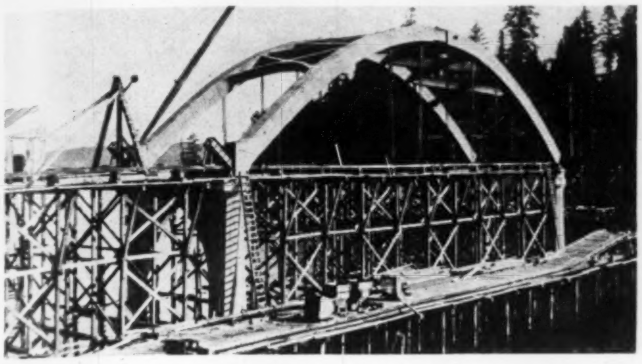
A series of equal spans was first considered, but because of the change in elevation at each panel point due to the roadway grades at Coos Bay and Yaquina Bay, this plan was abandoned in order to avoid the resulting varying heights of the spandrel columns on successive arches, which was felt to be neither economical nor pleasing in appearance. As actually constructed, the percentage of rise to length of arch is nearly constant, varying from 35 to 38 per cent.

Each arch at Coos Bay and Yaquina Bay is divided into 11 equal panels which vary in length with the different structures. The floor beams and short columns near the center of the structure tend to tie the deck to the rib and prevent true arch action. In order to reduce the restraining action of the deck on the arch, six of the ten columns were provided with hinges or rockers, or both. Only the second and third columns from each end were attached rigidly to both the deck and the rib. As these columns are relatively small and slender, they are not considered to exert much influence on the stresses in the arch. Considère hinges were used at the crown and at the skewbacks.

One end of each of the end arches at Coos Bay was founded on rock while the others were supported on piling. To provide for the unbalanced dead-load thrust, the three outside rows of piling opposite the longer arch were battered 1 in. in 12. The piers supporting the outer ends of the anchor arms of the cantilever and the ends of the 265-ft arches, had 493 piles battered 1 in. in 10, and 116 straight piles. No attempt was made to provide for the unbalanced live load as it was considered that the stiffness and resistance of the vertical piling would take care of it.

CONCRETE ARCHES FAVORED TO REDUCE MAINTENANCE

Tied concrete arches were used on three of the bridges. Two 154 ft long and one 210 ft long were used at Alsea Bay, four 154 ft long at Umpqua Bay, and two 154-ft spans over the Suislaw River. The ribs for the 154-ft arches are of constant cross-section. Decks are carried on floorbeams supported by hangers on 14-ft centers. The arches are braced laterally by sway braces, the lower one at each end being curved and acting as a portal. The lower chords or arch ties are composed of four eyebars anchored to the concrete arch by being pinned to two I-beams. These I-beam struts are buried along the axis of the arch and anchored by means of angle-iron lugs, which are riveted around the I-beam section at 18-in. intervals.

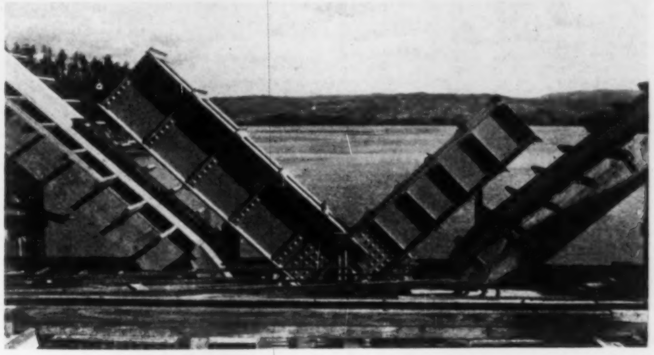


Hangers and Bottom-Chord Bars for Umpqua Bay Tied Arches Were Concreted Last

These arches are supported on welded structural-steel shoes of the type ordinarily used for steel bridges. One shoe rests on rollers which allow end motion due to elongation of the bottom chord. In order to provide freedom for this lengthening, the cord bars were kept free from the floorbeams until the remainder of the arch was completed. The skewback section of the arch was also kept free from interfering parts so as to permit rotation about the end pin.

To avoid excessive cracking of the concrete, the hangers and bottom-chord bars were not encased until the rest of the structure was completely poured; thus the concrete was not subjected to dead-load elongation, and stretching caused by the live load has not been sufficient to produce cracks in these members. These structures were designed as three-hinged arches under dead load and as two-hinged arches under live load, owing to the use of the Considère hinge.

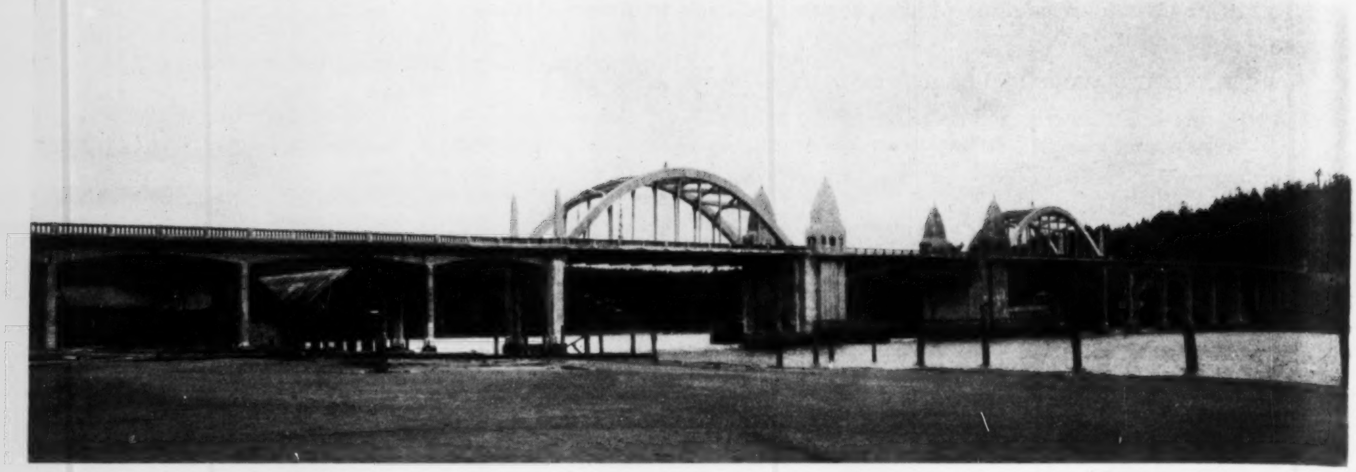
As has been mentioned, Considère hinges were used to eliminate some of the secondary stresses. The hinges were made by casting a section of concrete 8 to 12 in. in thickness, about 12 in. long and nearly the full width of the arch, and leaving the remaining section of the arch and the reinforcing steel unconnected until the structure was complete. The reinforcing bars were then welded together and the slots in the arch filled with a dry, rich concrete mix well tamped into place. The use of these hinges at crown and skewbacks makes the arch statically determinate. As the thrust acts through the center of the hinge, all bending in the hinge is eliminated. The secondary effects of temperature stress, shrinkage, elastic rib-shortening, plastic flow, and support displacements are reduced by the use of these hinges. This condition is particularly important in the case of the tied arch with the excessive elongation of its bottom chord, but it is also important with a fixed arch supported on piling. In computing the size of the hinges required, a stress of 2,000 lb per sq in. over the gross section was allowed in the concrete.



Structural Steel Details at Pins, Alsea Bay Tied Arches

For economy, continuous-beam spans were used instead of arches at the ends of each bridge. It was found that two series were sufficient, one consisting of 56-ft 70-ft, and 56-ft spans, and the other of 42-ft, 56-ft, and 42-ft spans. One span in each series had an expansion joint at one end, but the other two spans are built integrally with the columns, and dependent upon the bend-

A 430-Ft Center-Bearing Swing Span Was Used Over the Main Channel of the Umpqua River



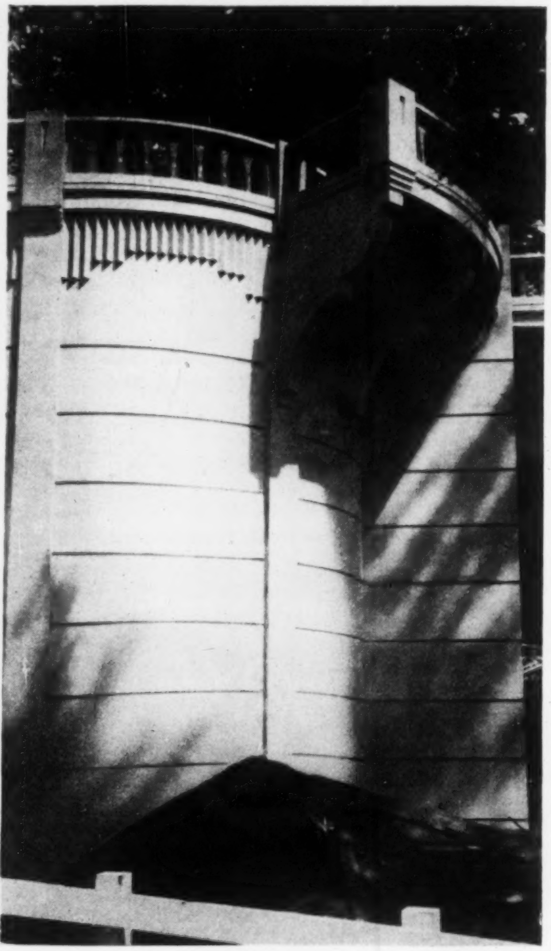
COUNTERWEIGHTS FOR THE SIUSLAW BASCULE SPAN DESCEND INTO THE HOLLOW PIERS
Use of Wood with an Asphalt Wearing Surface Provides a Light-Weight Deck

ing in the columns to provide for expansion. The change in temperature is so slight along the coast that it was not necessary to hinge the end columns. These spans were designed as continuous girders in which the slab acts as a flange and the haunches at the columns take the negative moment. Two columns connected by heavy cross-beams support the superstructure.

DESIGNING THE COOS BAY CANTILEVER

The first problem in connection with the cantilever at Coos Bay was to design a structure having the clearances required for river traffic, the proper grade for highway traffic, and a reasonably good appearance. A satisfactory solution was finally obtained by raising the ends of the trusses as much as possible and providing structural steel pylons with an attractive portal. The shape of truss finally approved was a half-through structure with bracing both above and below the deck, thus ensuring rigidity.

An effort was made to keep the dead load on the cantilever arms and suspended span as light as possible. The 6-in. concrete deck, heavily reinforced for both tension and compression, was nearly as light and more economical than any other form of deck investigated. Silicon-steel stringers, supported on the floor-beams and acting as continuous beams, helped to further reduce the dead load. No latticing was used on the structure. Instead, the sections were composed of solid webs or box sections, and where necessary to provide openings for inspection or painting of closed members, diamond-shaped holes were cut in the lower plates. This type of chord proved stronger than one using lattice bars would have been, produced a more pleasing appearance, reduced the rust hazard, and simplified painting. Built up of structural-steel shapes, the main posts which carry the loads to the pier form cellular spaces decreasing in number from eight to two at the upper chord.



ATTRACTIVE CURVED BRACKET AT END PLAZA, COOS BAY BRIDGE

Working stresses used in the design of the structural steel for the cantilever varied somewhat from those allowed by the American Association of State Highway Officials. Instead of using 24,000 lb per sq in. in tension for dead load, plus 200 per cent of live load, plus impact, it was decided that since the dead-load stresses made up such a large proportion of the total, the stresses should be limited to 20,000 lb per sq in. for the dead load, plus 150 per cent of live load, plus impact. Under the same conditions, a stress in silicon steel of 27,500 lb per sq in. was allowed. For the floor system stresses of 24,000 lb per sq in. in the carbon and 33,000 lb per sq in. in the silicon steel were allowed for the dead load, plus 200 per cent of live load, plus impact.

The bases of the main piers for this structure were 43 ft by $90^{1}/_{2}$ ft over-all, supported on 608 piles. The upper part of each pier was reduced to two sections 11 ft by 18 ft, tied together by concrete cross-braces. The piers were flared out at the water line and were scored both vertically and horizontally, giving them a fine appearance.

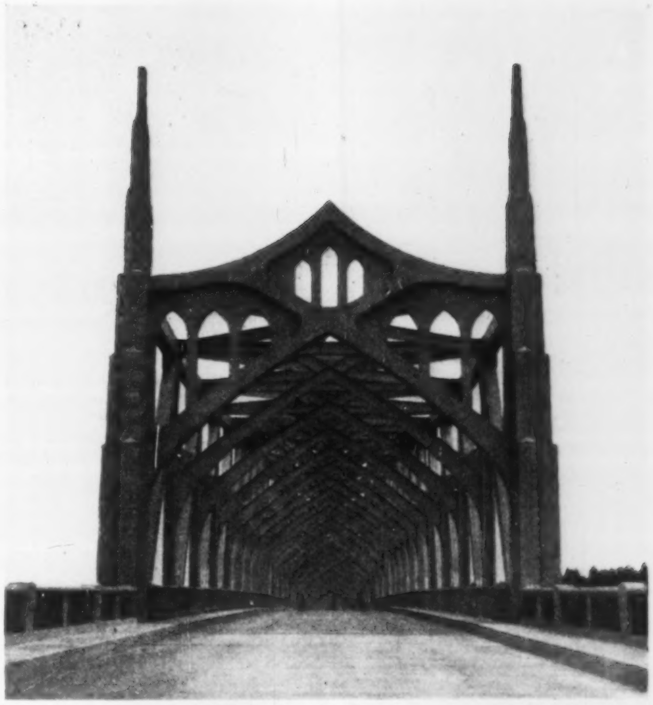
FIXED ARCH USED AT YAQUINA BAY

Second in length to the Coos Bay crossing is the steel arch over Yaquina Bay. The main span consists of a half-through arch 600 ft in length, with a 350-ft deck arch at each side. The 600-ft structure has a rise of 210 ft center to center of pins, while the 350-ft arches have a rise of $93^{1}/_{2}$ ft. These arches were designed as three-hinged structures under dead load, and after the concrete decks and handrails have been placed, the upper joints will be riveted up, making the arches two-hinged. Diagonals and struts, like the Coos Bay bridge, are composed of sections with solid webs, few batten plates, and no lacing. The chords are box sections and the webs of the arches are I-sections made up of I-beams and channels. The hangers consist of I-beams suspended from the top chord by cast chromium-steel pins. This system of hangers was used to prevent trouble from repeated bending due to the vibration of the long members.

Allowable stresses similar to those used at Coos Bay were adopted, except that a wind load 100 per cent greater than normal was used. Under this condition, the usual dead load was used, but no live load. A carbon-steel stress of 28,800 lb per sq in. was allowed, together with a silicon-steel stress of 39,600 lb per sq in. The high wind load which was deemed necessary because the structure will be exposed to strong southwest winds, required the use of a special anchorage heavy enough to provide for the wind load during erection without additional bracing.

The 430-ft center-bearing swing span used over the main channel of the Umpqua is unusually heavy on account of its concrete deck. Solid web and box sections were used. A 60-hp motor furnishes power for operating the main span, while 5-hp motors operate the end lifts.

The main channel of the Siuslaw is spanned by a 140-ft double-leaf bascule powered by two 15-hp motors. The bascule leaf is balanced by a concrete counterweight which descends into the pier. The live load on the truss is transmitted to the front wall of the pier through a bearing shoe, as a lug on the back of the truss engages an anchor in the back wall of the pier. The bascule is of the steel deck-truss type, operating on 14-in. trunnions. Each trunnion is supported by two columns instead of by the usual trunnion girder. It was necessary to provide a slot in the counterweight in order to obtain clearance for the inter-columns when the bridge opens. In order to provide a light deck for the movable part of the structure, Port Orford cedar lumber was used with an asphalt plank wearing surface. The piers are hollow and massive for the length of the structure, being 39 ft by 50 ft 6 in. in size.



The Arched Sway-Bracing at Coos Bay Is Particularly Striking

Considerable time and thought were expended in an effort to make all these structures as pleasing in appearance as possible within a reasonable cost. Similar architectural types have been employed in nearly all the bridges. Horizontal and vertical scoring, fluted columns, pylons, cross-beams shaped like Gothic arches, curved brackets, and attractive handrails have been used. Even in the steel structures, pleasing effects have been secured through the use of curved struts and bracing. The effect of the arched sway-bracing is particularly striking at Coos Bay. I believe that the design of modern bridges must consider the architectural as well as the structural features, and that the extra expense involved in obtaining a pleasing appearance is justified.

Construction of Coast Highway Bridges

By G. S. Paxson

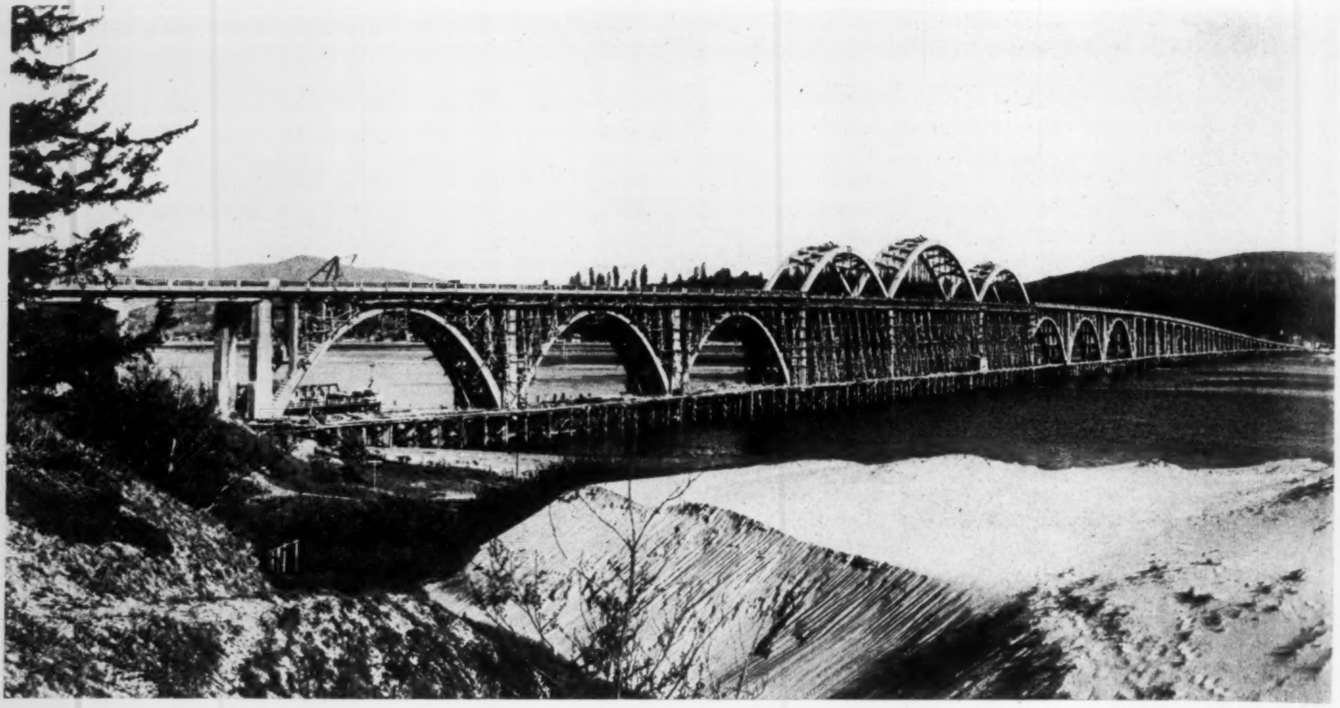
Associate Member American Society of Civil Engineers
Acting Bridge Engineer, Oregon State Highway Commission, Salem, Ore.

An interesting diversity of construction problems is involved in the five major bridges now nearing completion on the Oregon Coast Highway. While no one of the structures is of great size, each is an individual type presenting its own problems. Moreover, each of the five structures was built by a different contracting organization, and of course no two contractors approach a construction problem in quite the same manner.

At Newport, a 600-ft steel arch spans the main ship channel along the north side of Yaquina Bay, flanked on each side by a 350-ft steel arch. The southerly part of the bay is quite shallow. It is partly above water at low tide, but at high tide a considerable current sweeps across the sand flats and occasionally carries heavy drift. Concrete arches of varying lengths connect the southerly arches with the south shore of the bay. The north and south approaches to the arches consist of concrete viaducts 233 ft and 549 ft in length, respectively. The contract for the Yaquina Bay Bridge, in the amount of $1,357,857.50, was awarded July 25, 1934, to the Gilpin Construction Company of Portland and the General Construction Company of Seattle, as a joint venture. The bridge was opened to traffic September 6, 1936.

CONCRETE USED EXCLUSIVELY AT ALSEA BAY

The Alsea Bay Bridge, which has a total length of 3,028 ft, is a reinforced-concrete structure throughout. Proceeding from the north end, it includes 124 ft of viaduct; three 150-ft deck arches; a series of three tied arches across the navigable channel, having spans of 154 ft, 210 ft, and 154 ft, respectively; another series of three



The Alsea Bay Bridge, 3,028 Ft in Length, Is a Reinforced-Concrete Structure Throughout

150-ft deck arches; and 1,354 ft of viaduct. On April 25, 1934, the contract for this structure was awarded jointly to Lindstrom and Feigenson, Parker and Banfield, and T. H. Banfield. The structure was opened to traffic May 9, 1936, and all work was completed by June 15, 1936. The total cost was $746,290.33.

At the Siuslaw River, a double-leaf bascule span provides a clear distance of 140 ft between piers. Flanking this draw span at each end is a 154-ft tied concrete arch. The north and south approaches are concrete viaducts 478 ft and 650 ft in length, respectively. The total length of the structure is 1,650 ft. The contract was awarded to Mercer-Fraser Company of Eureka, Calif., on July 25, 1934. The structure was opened to travel on April 1, 1936, and all work was completed on April 10, 1936, at a cost of $502,127.10.

The Umpqua River Bridge consists of a 430-ft steel swing span across the navigable channel and two 154-ft concrete arches, identical with those for the Siuslaw River Bridge, at either end of the span. Eighty-four feet of concrete viaduct on the north end and 1,072 ft on the south give the structure a total length of 2,213 ft. The contract was awarded to Teufel and Carlson of Seattle, on July 25, 1934. All work was completed on April 7, 1936. The total cost was $549,818.81.

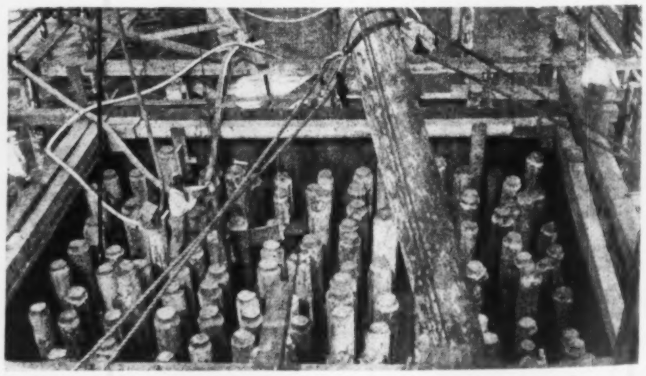
Largest of the coast highway bridges is that across Coos Bay. It consists of a 1,708-ft cantilever bridge having a main span of 793 ft and anchor spans of 457 ft 6 in. The north approach includes seven concrete deck arches varying in length from 151 to 265 ft and 492 ft of concrete viaduct. The south approach consists of six concrete deck arches varying from 170 ft to 265 ft in length, and 233 ft of concrete viaduct. The total length of this structure is 5,337 ft. It was placed under contract in two units, the piers and concrete approaches being awarded to the Northwest Roads Company of Portland, and the cantilever span to the Virginia Bridge and Iron Company of Roanoke, Va. The contracts were awarded on July 25, 1934. The structure was opened to traffic on May 9, 1936, and all work was completed September 15. The total cost, as of June 1, 1936, was $2,094,162.41.

In the pages which follow, a few of the more unusual problems will be discussed and the methods used in meeting them described. [Photographs of the Yaquina Bay, Siuslaw River, and Umpqua River bridges appear in the accompanying article, "Design of Coast Highway Bridges," by O. A. Chase.]

PIERS CONSTRUCTED ON PILES IN COFFERDAMS

All these structures are over tidal estuaries, and the foundations were constructed in sand, for the most part. Cofferdams were of steel sheet-piling, except at the Siuslaw River Bridge, where timber piling was used, made up of 8 by 16-in. timbers grooved both sides and connected with splines. Timber wales and struts were used to support the sheet piling except at the two main piers of the Yaquina Bay Bridge, where steel wales and struts were used in the lower sections.

Foundation piles were driven with the aid of jets to within 5 ft of their final positions. The jet was then withdrawn in each case and the final 5 ft driven without its aid, although some difficulty was experienced in so doing. In their final positions, the bearing value of the



Interior of a Cofferdam, Alsea Bay Bridge

After the Piling Had Been Driven, Excavation Was Effected by Means of a Hydraulic Ejector piles, as computed by the *Engineering News* formula, was well above 20 tons per pile.

At the Yaquina Bay Bridge, the contractor elected to use an underwater hammer so as to employ shorter piles. Channel iron leads, telescoped into the fixed leads of the driver and lowered to the bottom of the excavation, were used as guides for the hammer. The latter was of the double-acting steam type, with the striking parts entirely enclosed in a steel shell. Air pressure applied to the shell kept out the water. The exhaust was carried to the surface through a hose. In driving battered piles, inclined leads sloping forward at the required batter were used. No particular difficulty was experienced in spotting these piles or in maintaining the proper batter.

Erecting Forms for Supporting Columns on One of the Coos Bay Arches

Electrically Driven Vibrators Were Used Throughout

Except where made necessary by interference, the piles were not cut off until after the concrete seals had been placed by tremie and the cofferdams unwatered. In no case was a seal used of sufficient depth to balance the full hydrostatic head. With a head of 35 ft, an 8-ft seal was placed; with a head of 30 ft, the seal was reduced to 6 ft. The minimum depth of seal was 4 ft, with a head of 20 ft. To balance the remaining hydrostatic head, dependence was placed on the resistance of the piling to pulling and on the grip of the seals.

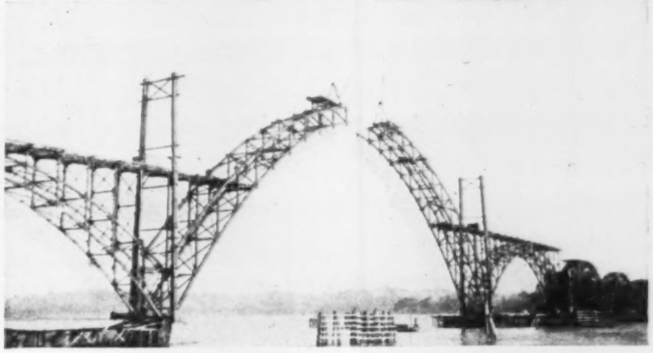
Tests to determine the bond strength of wood piles in concrete as described by R. R. Lundahl, M. Am. Soc. C.E., in the 1923 Transactions of the Society, gave an ultimate value of more than 55 lb per sq in. of pile. These tests were made on single piles and did not take into account the locking effect of a large group, which in practice are never parallel. With the hydrostatic heads encountered and the depths of seals used, the bond per square inch of pile embedded did not exceed 5 lb. The grip of the seals on the piles was not, therefore, a controlling factor.

PILES RESIST HYDROSTATIC PRESSURE ON CAPS

A 35-ft head of water with an 8-ft seal and piles spaced $2^1/_2$ ft on centers results in an unbalanced load of approximately $3^1/_2$ tons per pile. While this was considered to be safe, a test was made to determine the value of piles in pulling. Three piles were driven in a row, the outer ones cut off at a convenient height, and a cross-bar framed into the center pile. Upward thrust was applied to the cross-bar with hydraulic jacks equipped with pressure gages, and a reference mark on the center pile was observed with a level. A thrust of 36 tons produced an uplift of approximately $^1/_{16}$ in. At this point the cross-bar broke, but as this value was far above that required, the test was not repeated.

It was recognized that the resistance of a single pile to pulling may be no criterion of the resistance of a large group. To insure against the possibility of lifting a section of the stream bed, the weight of material gripped by the piles was made the limiting factor. It was assumed that the line of cleavage would slope outward from the bottom of the piles on a $^1/_4$ to 1 slope. This assumption was made without supporting tests, but the successful unwatering of the piers leads me to believe that it is well within the bounds of safety.

The fine sand of which the bay bottoms are composed is constantly shifting with the tidal currents. The placing of piers, falsework, or other obstruction in these currents resulted in a tendency to scour, which was taken care of by riprap. Scour was particularly bad at the Alsea Bay Bridge. Before riprap could be placed around the piers of the approach bents, the bottom had scoured out as much as 13 ft in some places to points below the bottoms of the footings, leaving the piling exposed to attack from marine borers. Bundles of brush approximately 8 ft long and 2 ft in diameter were weighted with concrete-filled bags and sunk around the footings. As the tidal currents carry a great deal of sand, these brush bundles, by retarding the velocity of the current, caused the sand to be redeposited in and around the piers. In this way the bay bottom was built up layer by layer until the sand was eventually brought back to its original elevation. The entire bottom adjacent to the piers was then riprapped with rock. The cost of this treatment was approximately one-third the estimated cost of filling the entire volume with rock, and it is felt that equal results were attained.



The Main Arch at Yaquina Bay Was Tied Back to the Adjacent Spans During Erection

Cables for This Purpose Were Carried Over Falsework Towers

CONCRETE VIBRATORS EFFECTIVE

Concrete for all five structures was mixed at central mixing plants, using aggregates obtained from river or beach deposits. At the Yaquina Bay job, the mixing plant was constructed on a barge, being moved from one side of the bay to the other as the work progressed, and the concrete was transported from the mixing plant to the various parts of the project by truck. On the Alsea Bay, Siuslaw River, and Umpqua River jobs, one mixing plant served the entire project, the concrete being transported across the falsework. At the Coos Bay job, a mixing plant was erected on each side of the bay.

Vibrators of the internal type, in which the vibrating element is placed directly in the concrete, were specified in placing all concrete. Both the rigid-shaft type and the flexible-shaft type were employed. Air-driven vibrators were used exclusively at the Yaquina Bay Bridge, while electrically driven machines were used on the other four projects. Excellent results were obtained in each case.

The specifications for this project required the contrac-

THE TWO-MILLION-DOLLAR COOS BAY BRIDGE HAS A MAIN CANTILEVER SPAN 793 FT LONG

The specifications for this project required the contractor to bid on a concrete containing a fixed amount of cement. If the engineer who controlled the mix required the use of more cement than specified, the contractor was to be reimbursed for the cost of the additional cement. If the mix set required less cement than specified, the cost of the cement saved was to be deducted from the contractor's estimate. The amount specified was based on experience with hand-placed concrete. It was found that a saving of about $^3/_4$ sack of cement per cubic yard of concrete could be effected by the use of the lower water-cement ratios made possible by vibration.

Like most bridge jobs, there were many sections that were thin, difficult of access, or badly restricted by reinforcing steel. With hand-placing of concrete, gravel pockets and surface imperfections would have been expected, and the absence of such imperfections must be largely attributed to the use of vibrators. The usual trouble with air bubbles was experienced along the forms. This was decreased by careful spading along the form surfaces, but we were never able to entirely prevent their formation. These projects represented our first experience with vibrators, except for one job on which we experimented with a home-made machine consisting of a chipping hammer. The results were so highly satisfactory that we have made the use of vibrators standard on all bridge work. Forms were made in sections in carpenter shops and put together on the job as far as practicable. In this way, carpenter work on the falsework was held to a minimum.

UNUSUAL STEEL ERECTION METHODS AT YAQUINA BAY

Erection of structural steel at Yaquina Bay and at Coos Bay presented some rather interesting features. At the Yaquina Bay Bridge, the necessity for keeping the channel open precluded the use of falsework for the main arch. As falsework for the 350-ft side spans would have been quite costly because of the height of the arches, the contractor used only four falsework bents under each of the latter spans. Timber bents were erected under the second and fourth panel point from each pier, and the steel was cantilevered out from these bents toward the center of the arch. Jacks were placed on top of the second set of falsework bents in order to adjust the elevation of the arch as erection progressed. No difficulty was encountered in adjusting the height and distance for making the closures.

Both of the 350-ft arches were closed before the erection of the 600-ft span was begun. The first three panels at each end of this span were tied back to the 350-ft spans by cables. A timber tower 213 ft in height was erected on each main pier and anchored by cables to eye-bars in the small piers at the ends of the 350-ft arches. Supporting cables were carried from the tower to the fourth panel point of the arch, and erection then proceeded by cantilevering out until seven panels had been erected from each pier. At this point a second cable from the tower was attached to the top chord of the arch. In order to equalize the stresses in the two supporting cables, the free ends were connected through a series of blocks. The half spans were erected approximately 6 in. higher than the design called for, and closure was effected by slacking off on the supporting cables. Erection of the steel was handled by stiff-leg travelers which were carried along the top chords of the arch as the erection proceeded.

ERECTING A CANTILEVER WITHOUT OBSTRUCTING THE CHANNEL

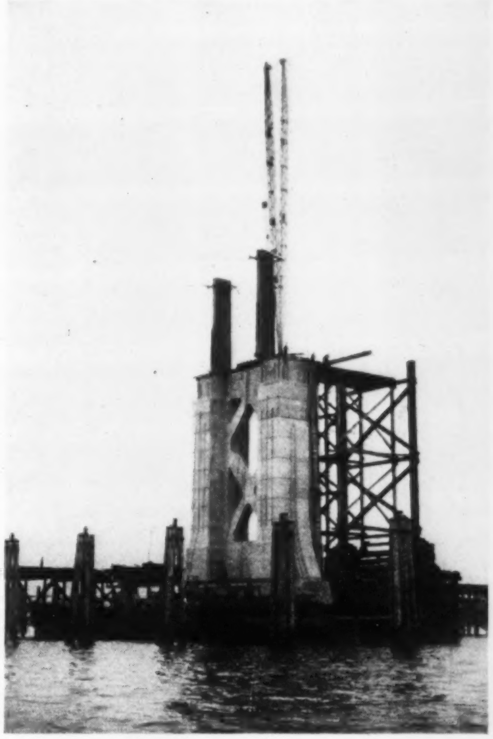
At Coos Bay, a vertical clearance of approximately 150 ft above mean high water was required for navigation. The bay bottom is the soft sand and muck typical of bays and inlets which receive relatively small amounts of fresh water. Falsework to support the steel anchor arms in the conventional manner would have required long and expensive piling and high falsework, so the contractor chose a method of erection new to the Pacific Northwest, as far as I know. As used in the East, this method consisted essentially of placing one falsework bent under the first panel point inshore from the main pier and balancing the truss on these two supports.

At the Coos Bay Bridge, however, the falsework bent was erected under the second panel point inshore from the main pier. This bent rested on two 16-pile clusters capped with timber grillages, 61 ft from the center of bearing on the pier. While the reactions both at the main pier and at the falsework bent had been carefully calculated for each stage of erection, it was felt that a check was desirable. Two 275-ton hydraulic jacks, fitted with pressure gages, were placed on top of each post of the falsework bent under the bottom chords of each truss. The pressure in the jacks gave the reactions on the falsework bent at all times.

A guy derrick mounted on a projection of the pier base a few feet above high water was used to erect, between the falsework bent and the pier cap, a working platform consisting of steel stringers later to be used in the floor system. The guy derrick was then raised to this working platform.

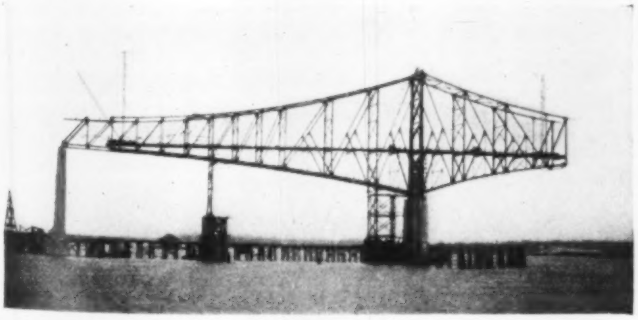
The steel tower at the main pier was shipped in four sections, the heaviest of which weighed 36 tons. The first two sections were erected with the derrick resting on the working platform. The sections of bottom chord out to the false bent, together with the diagonals, vertical posts, and floor system for these two panels up to deck level, were also placed.

Then the guy derrick was raised to its third position, resting on the stringers of the floor system. Since it was necessary to move the derrick out along the floor system as erection proceeded, the base casting of the derrick was placed on a sled, whose runners consisted of short sections of channels with the flanges turned down over the flanges of the stringers. Red lead was first tried as a lubricant, but as it showed a tendency to jam and cause a jerking motion which set up excessive vibrations in the truss, it was abandoned in favor of stiff cup-grease.


First Two Sections of the Steel Tower for the Main Piers at Coos Bay Were Erected with the Derrick on the Working Platform

BALANCING THE COOS BAY CANTILEVER

After the first guy derrick had completed the erection of the first two panels, an identical derrick was assembled on the floor system. The two derricks were moved out in opposite directions, placing the steel so that the load was practically balanced on the main pier. In order to insure against overturning, anchor-arm erection was kept slightly ahead of the cantilever arm so as to maintain a minimum load of 200 tons and a maximum load of 400 tons on the falsework bent.


Landing One of the Coos Bay Anchor Arms
Two Falsework Bents Under Each Anchor Arm Sufficed for Support While Erecting the Cantilever

When the anchor arm was 275 ft in from the main pier, a second falsework bent was erected at this point on which the load of the truss was taken. From this point to the pier at the inshore end, the anchor arm was kept considerably heavier than the cantilever. No difficulty was experienced in landing the truss on the end pier, as the jacks afforded an ideal means of raising or lowering it to exact position.

Since all the steel work was self-supporting, the riveting was kept close behind erection. This slowed down the erection considerably, as skilled riveters were not available in sufficient numbers to keep up with the erecting crews.

After the completion of the south anchor and cantilever arms, the equipment was moved to the north pier and the procedure repeated. The suspended span was then erected from each end of the cantilever and closure made at the center. Minor changes were made in the original design to permit the use of this method of erection. The top chord was tied back to the top chord of the cantilever arm with eye-bars, and one of the hydraulic jacks was placed between specially constructed seats in the bottom chord for use in making the final closure.

An interesting feature was the procedure in caring for truss deflections during erection. As the weight of the suspended span would cause the anchor arm to rise and would pull the main towers forward, the towers were erected $1^{1}/_{2}$ in. out of plumb. The cantilever erection of the suspended span resulted in an increase in moment over that obtaining when the span was joined, and the load simply applied at the end of the cantilever arm. This increased moment caused the cantilever arms to deflect downward approximately 3 in. below their final position. Without the jacks in the bottom chord, closure would have been difficult.

ACKNOWLEDGMENTS

Design of these five structures and supervision of their construction in the earlier stages was under the direction of C. B. McCullough, bridge engineer for the Oregon State Highway Department, now on leave of absence with the Bureau of Public Roads on the Pan-American Highway in Central America. The details of construction were under the supervision of the writer, assisted by A. G. Skelton, Assoc. M. Am. Soc. C.E., as project engineer, and by resident engineers on each of the five jobs.

Appreciation is expressed of the advice and counsel of the PWA staff and the manner in which our relationships were conducted throughout the work, particularly on the part of C. C. Hockley, Assoc. M. Am. Soc. C.E., state director, and his staff; R. H. Corey, M. Am. Soc. C.E., state engineer inspector; and the resident engineer inspectors. This department was fortunate in the contractors to whom the work was awarded. Their skill, experience, and ability were demonstrated again and again, and it is a pleasure to acknowledge their cooperation.

To Protect Portland's Water Supply

Sanitary Precautions in Construction, Distribution, and Use Prove Most Effective

By Ben S. Morrow

Associate Member American Society of Civil Engineers

Chief Engineer and General Manager, Water Bureau, Portland, Ore.

Portland's water supply, from the picturesque Bull Run watershed in the Cascades, enjoys natural protection against contamination. Regulation of the surrounding government forest preserve is careful and effective, and the inflow to the system is therefore inherently pure. Unwilling to risk any possibilities of infection, the city has taken extreme measures to insure against subsequent contamination. Mr. Morrow explains the care taken in water works and CCC construction, in the logging operations on a small part of the watershed, in chemical treatment, and in the city distribution system. Portland is fortunate in that its citizens demand and appreciate a water supply nothing short of the best. This informative paper was delivered before the Sanitary Engineering Division on July 16, 1936, at the Society's Portland Convention.

For the past 41 years Portland and its contiguous territory has obtained its water supply from the Bull Run River, the point of diversion being about thirty miles east of the city. The tributary watershed is within the Bull Run division of the Mt. Hood National Forest. This area was set apart as a public reservation by proclamation of President Harrison in 1892, at which time further entry or settlement on federal lands within the area was prohibited. In 1904 Congress passed an act to protect the Bull Run Forest Reserve and Portland's water supply from trespass or grazing of stock.

The reserve is an area of 218 sq miles, lying on the western slope of the Cascade Mountains. At the time it was established it included about 21,000 acres in private ownership, 11,000 acres of which were Oregon and California railroad lands, title to which latter reverted to the federal government. Of the remaining 10,000 acres, the city has acquired 3,740 by purchase, and the federal government has regained title to over 4,000 acres through exchange for timber lands in other localities. At present about 2,100 acres remain in private ownership, but these lands lie entirely outside the watershed, and except for about half of a section of agricultural land located three miles downstream from the diversion, are valuable only for the timber.

Above the diversion the watershed of the Bull Run River has an area of 102 sq miles and lies between Els. 750 and 4,700. This part of the Cascade Range is composed entirely of volcanic rock occurring in four formations: the lower, a basaltic lava composed of a series of many heavy flows; next above, a fragmentary volcanic rock of hard, bouldery agglomerate, cemented gravel, sandstone, and ash; overlying this, a series of andesitic lava flows; and at the top, gravel and boulders, glacial materials, soils, and cemented gravel.

About 80 per cent of the area of the watershed is in first-growth timber, mainly fir, with some cedar, hemlock, and larch. About 15 per cent has been burned over in times past, and on most of these burns a substantial second growth has developed. Logged-off lands, rock slides, and lake areas account for the remainder. It is estimated that there is a total of 4,200,000 million fbm of timber in the reserve.

WATER OF GOOD QUALITY

For the past 41 years of record, the average flow of the river at the headworks has been 812 cu ft per sec, with a maximum flood of 21,000 cu ft per sec and a low flow in late summer of 64 cu ft per sec. The main branch of the river has its source in Bull Run Lake, close to the summit of the Cascade Mountains at El. 3,175. This lake, about 500 acres in area, has no surface outlet; instead the outflow appears about a mile down the canyon in a series of large springs at an elevation 175 ft below the lake surface. Contrary to the old popular

Bull Run Lake, near the Summit of the Cascades, in Mt. Hood National Forest

A Natural Reservoir of Portland's Water Supply System belief, none of the water of the Bull Run comes from the glaciers of Mt. Hood, but rather from innumerable springs and small creeks fed by melting snows and rainfall, which is very heavy on the western slopes of the Cascades.

The water is of excellent quality for domestic supply. The results of analyses taken at 10-day intervals throughout the year by the U. S. Geological Survey show the following averages:

CONTENT	PARTS PER MILLION
Total dissolved solids	30
Silica (SiO_2)	9
Iron (Fe)	0.03
Calcium (Ca)	2.7
Magnesium (Mg)	0.5
Sodium (Na)	3.1
Potassium (K)	0.5
Bicarbonate (HCO_3)	12.0
Sulfate (SO_4)	3.1
Chloride (Cl)	1.3
Nitrate (NO_3)	0.31
Total hardness as $CaCO_3$	8.8

THE HEADWORKS OF PORTLAND'S WATER SUPPLY SYSTEM ARE LOCATED IN A SETTING OF NATURAL BEAUTY

With the reserve closed to the public by the federal government, the greatest danger of pollution would come from logging operations on the limited areas held under private ownership, or from laxity in administering the law against the trespass of campers and from stock grazing. As early as 1890 the Bridal Veil Timber Company was carrying on logging operations along the north boundary of the reserve on the southern slope of Larch Mountain. The company is still logging off its timber holdings along the northern limits of the reserve, on lands outside the watershed.

THE BULL RUN STORAGE PROJECT INSURES PORTLAND AGAINST WATER SHORTAGE

The Dam, 200 Ft in Height, Creates a Reservoir of 11-Billion-Gallon Capacity

Within the reserve, logging operations have been carried out in a careful manner, with a thorough clean-up of debris under the supervision of the Forest Service. The work was done in sections so far removed from the main river, or its major branches, as not to endanger the quality of the water supply in any way. It has been many years since a lumber camp was operated within the reserve, and even when a camp was there its location and manner of operation were such as to give no cause for complaint.

Fortunately the reserve is under the administration of the U. S. Forest Service, which has always shown a deep appreciation of the importance of maintaining the high quality of the water supply. An ample number of guards are provided at all points of entry for protection against trespass, and the fact that the federal courts have shown no leniency to persons guilty of unlawful entry into the reserve has gone far toward making the exclusion of the public a reasonably easy matter.

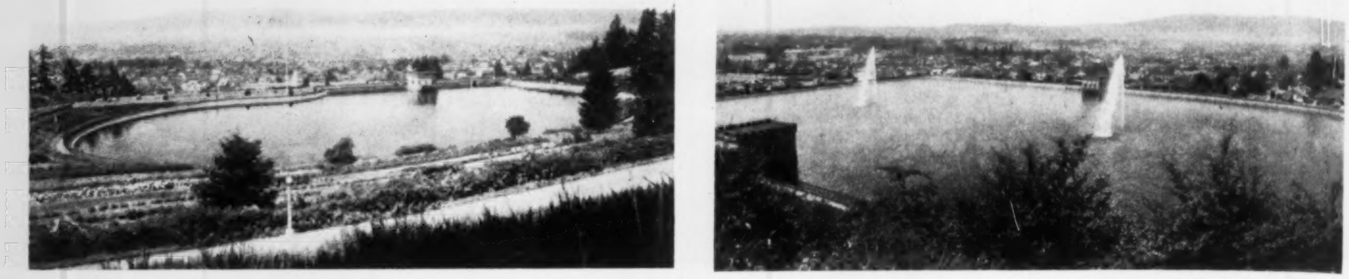
AUGMENTING THE NATURAL SUPPLY

The peak demand on the water system, about 72 mgd, occurs during the summer season when the natural flow is approaching the minimum. It was necessary therefore to develop storage to meet this demand. The first development of three billion gallons was made at Bull Run Lake. By 1927 it was necessary to increase the storage, the lake not being susceptible to additional development on account of its limited watershed, and the Bull Run storage project was constructed in 1928–1929. A concrete gravity dam 200 ft in height and 950 ft in length was built on the main river five miles above the headworks. This project stores 11 billion gallons, which, with the natural flow of the river, gives a sufficient supply for about 900,000 people.

In constructing the dam and clearing the storage basin, which extends for $3^1/_2$ miles along the river, about 600 men were employed. The city laid out a camp site, installed a water supply and sewer system, and employed experienced inspectors to make certain that sanitary regulations were properly observed. In the beginning it was a bit difficult to impress on the workmen the necessity of strictly observing the sanitary rules, but as soon as they learned that negligence meant dismissal no further trouble was experienced.

As the men came on the work they were examined for possible typhoid carriers. Garbage, in closed containers, was taken out of the reserve. Sewage was run through a large septic tank and the effluent discharged into another tank where it was thoroughly chlorinated and then pumped out of the watershed over a ridge 1,100 ft above the camp. While this sewage might have been taken care of more economically, the method followed seemed to allay any fear in the public mind that construction activities might affect the purity of the water—a matter in which Portland has always taken great pride.

At the time work was started on the dam, chlorinators were installed in the screen-house at the headworks, and sufficient chlorine was added to the water to give a residual of between 0.1 and 0.2 ppm. In 1932 the use of ammonia with the chlorine was begun; $^1/_2$ lb of ammonia and 2 lb of chlorine per million gallons gave satisfactory results. Such treatment with slight variation has been continued as a safeguard against possible pollution of the water above the diversion from any source. It takes the water from the headworks about seven hours to reach the distribution system reservoirs in the city, and the treatment has not occasioned complaint from users.



TWO UNITS OF PORTLAND'S WATER SUPPLY SYSTEM, LOCATED ON THE SLOPES OF MT. TABOR
The High Gravity Reservoir Is Shown at the Left, and the Intermediate Reservoir at the Right

ALL PRECAUTIONS TAKEN

The employment of CCC labor by the Forest Service during the summer months to develop fire roads and trails within the reserve has necessitated the construction of one 200-man camp within the watershed on the headwaters of the North Fork of the Bull Run River. In connection with these operations the government has taken precautions to remove possible sources of water contamination. The camp is at a safe distance from running water and has a complete water and sewer system, with a septic tank and retention tank for effective chlorination. A sanitary officer is delegated to see that the camp is kept clean and that sanitary regulations are properly enforced. Tests on the waters of the North Fork below the site during the time the camp was in operation indicated that no pollution was taking place.

Distribution reservoirs are not covered. In this climate, and with the character of water available in the Northwest on the western slopes of the Cascade Mountains, it would seem that the additional costs of covering the larger distribution reservoirs would outweigh the advantages. Daily tests of water taken from the reservoirs and of that taken from taps in the City Hall (which has passed through four of the distribution reservoirs), have not indicated any pollution from this source.

At one time we were considerably troubled by sea gulls settling on some of the reservoirs. But we soon found that the difficulty could be overcome by using wires stretched a few feet above the water surface and spaced so as to interfere with the birds when they took off. The gulls have given us no further trouble.

When new pipe lines are laid in the distribution system—which work is done by Water Bureau forces—the mains are sterilized before they are put in service. A small portable chlorinator is used for this purpose and gives satisfactory results.

The possibility of contamination from cross-connections to a non-potable supply is a source of constant concern to those charged with the operation of a water system. When river or well waters are readily available for industrial uses not requiring potability, there is the constant danger—in spite of laws and regulations to the contrary—that physical connections will secretly be made between the two supplies, usually as a stand-by service in case of interruptions to the pumping system of an industrial plant. Check valves leak; or gate valves are not tightly closed; or a change occurs in the operating personnel of the plant. The piping layouts in some of the old plants are a bit involved, and the unsafe waters are mixed with the potable supply. The results in many cases prove rather disastrous.

In almost any manufacturing district in Portland water can be obtained readily from fairly shallow wells or from the Willamette River. Many plants and office buildings have dual supplies. While almost all of those in charge appreciate the consequences of furnishing their employees and tenants with non-potable water for drinking, it nevertheless requires constant inspection to keep some enterprising plant engineer from putting in a cross-connection for ease of operation.

Where it is necessary to have both supplies available in a plant for a common use, the city requires that an elevated tank be installed and the potable supply discharged into the tank over the top, the pipe being high enough above the water surface so that the tank water cannot be siphoned back. A removable spacer between the two systems, which can be dropped into place when it is necessary to transfer the service from one system to the other, does not prove satisfactory, as the inclination is to let it remain in place and trust to the operation of the gate valves to protect the potable supply. Therefore such a hook-up is not permitted.

DAILY TESTS SHOW WATER IS OF EXCEPTIONAL QUALITY

In order that a proper record as to the condition of the water furnished the consumers may be had, daily bacteriological tests are made by the Bureau of Health Laboratories—on samples from the headworks, from the main distribution reservoirs, and from the laboratory taps in the City Hall. In addition, periodic tests are run on water from the various standpipes and tanks, and from parts of the distribution system as occasion arises. The tests are made in accordance with the standard method of water analysis of the American Public Health Association. Results show that the quality of the water furnished is far in excess of the most exacting requirements for drinking water.

Placing Hydraulic Fill at Fort Peck

Tests, Plant, and Methods Developed for World's Largest Earth Dam

By T. B. Larkin

Member American Society of Civil Engineers

Lieutenant Colonel, Corps of Engineers, U. S. Army; District Engineer, Fort Peck District, Fort Peck, Mont.

An earth-moving job that dwarfs all previous efforts of the sort is bound to command the attention of engineers. In this paper, supplementing his previous one in the July issue, Colonel Larkin gives a picture of the problems faced and methods evolved in piling up a four-mile mountain aggregating a hundred million cubic yards. To handle this by economical hydraulic methods a vast plant had to be built and efficient processes developed. Pipe lines of large size—up to 28 in. in diameter and 17,000 ft in length—have been kept in operation with remarkable persistency. Lifts as high as 200 ft have been accomplished. Inasmuch as a seven-month season is about the maximum in northern Montana, the record of over 30 million yards actually retained in these hydraulic fills within a period of less than a season and a half appears especially notable. Colonel Larkin's description of the huge task, as abstracted from his paper presented before the Construction, Power and Waterways Divisions at Portland, Ore., on July 16, 1936, should have wide appeal.

When completed, the Fort Peck Dam will be the largest earth dam in the world, containing approximately 100,000,000 cu yd of earth, all placed by pipe-line dredges. In view of the unusual construction hazards and the necessity for careful control of materials and coordination of operations, the dam is being constructed by hired labor and government plant. This paper will describe the planning procedure, construction plant, and methods employed in connection with the placing of the fill. For the general features of the project, reference may be made to my article in the July 1936 issue.

Because of the peculiar geological conditions existing at Fort Peck, an earth dam was the only practical structure. Throughout the valley the dense marine "Bearpaw" shale lies at an average depth of 100 ft, with a maximum of 160 ft, below the surface. The flood plain deposit was found generally to be excellent material for an earth dam. Hydraulic placement was indicated to be the most economical method for moving the large quantities of alluvium over the distances involved. Furthermore, by this method the materials are properly graded from coarse to fine toward the center to form an impervious core.

DESIGNING THE DAM

That portion of the dam lying across the valley has a length of 9,000 ft, a width of 2,875 ft, and a maximum height of 242 ft. Since the bluff on the left abutment is lower than that on the right, a smaller portion, more in the nature of a dike, extends westward 11,500 ft, making the total length of the dam 20,500 ft.

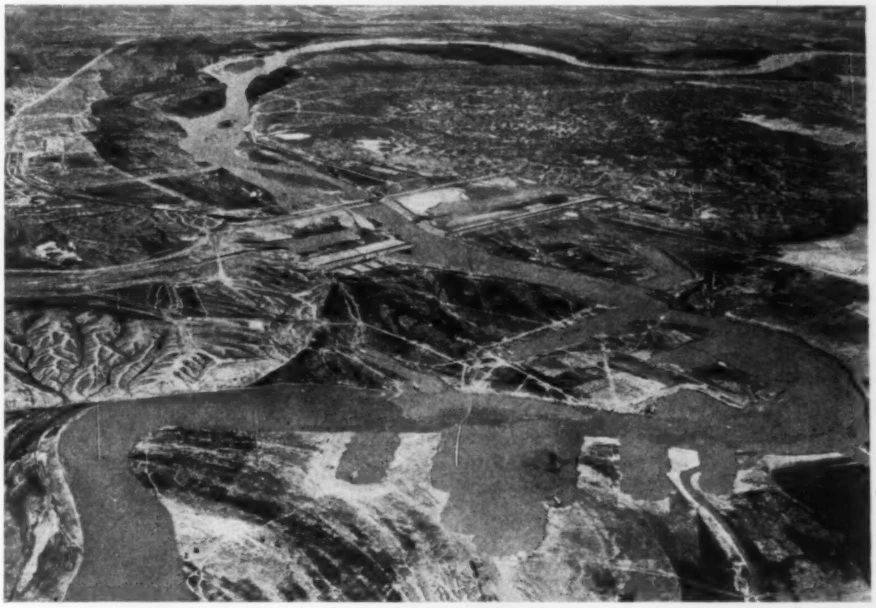
Heavy winds prevail in the northeastern section of Montana, and since there will be a maximum fetch of 25 miles, strong protection of the upstream face against wave-wash is essential. This will be provided by riprap built up in three layers. Next to the hydraulic fill, there will be 12 in. of gravel $^1/_2$ to 6 in. in diameter; then a 12-in. layer of quarry spalls (25 to 150 lb); and for the wearing surface, 24 to 36 in. of quarry stone, the minimum weight being 1 ton, and the maximum, 7 tons.

To secure information on the type of material in the borrow pits, extensive subsurface surveys are constantly being made. Soil profiles are made along all dredge cuts so that the proper depth to dig in order to obtain the best material can be accurately determined. Additional borings are made wherever field operations indicate this necessity.

To prevent piping and to reduce seepage it was decided that a cut-off wall of interlocking steel sheet-piling with $^3/_8$-in. web should be driven to the shale foundation. This wall, located $37^1/_2$ ft upstream from the axis of the dam, has a length of over 10,000 ft and a maximum depth of 163 ft below the surface. It was completed in December 1935.

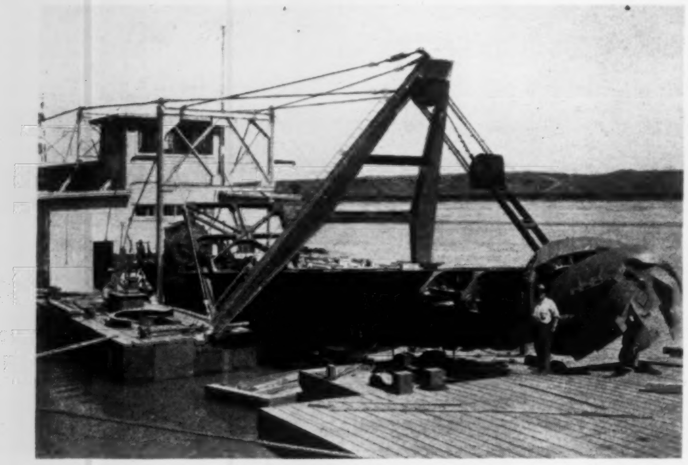
DREDGING PLAN DEVELOPED

In preparing plans for the dredging program, it was obvious that a channel had to be preserved for the flow of the river until the completion of the diversion tunnels. It was decided to build up the dam on either side allowing the river to continue in its normal channel until such time as closure could be made. It was necessary to secure all available borrow-pit material upstream prior to closure, that is, before completion of the diversion tunnels. Otherwise, there



Air View of Fort Peck Project in May 1936, Looking Northeast (Downstream)

Dredging Operations Show as Big Bites Out of Near River Bank; Dam Extends Through Center of View; Town of Fort Peck Beyond at Left would have been a shortage of downstream borrow within a reasonable distance. During the 1935 dredging season, all dredges operated with long pipe lines, the maximum being 17,280 ft with a 60-ft lift.



ONE OF FOUR GIANT EXCAVATING UNITS, SHOWING DETAIL OF LADDER AND CUTTERHEAD ON DREDGE "GALLATIN"

A Total of 14,000 Hp Is Required to Operate the Entire Unit, Including Pumps

This season, 1936, all dredges continue to work upstream. One dredge has been pumping into the dike section (Fig. 1), one discharging into the left bank section, and the other two into the right bank section, which is considerably the largest. Present plans call for the completion of the diversion tunnels in the spring of 1937, at which time the dredges will be moved downstream. All will then pump into the closure section, and after it is brought up to the height of the two sides, the entire embankment will be raised uniformly. Closure will commence immediately after the passage of the annual spring high water in 1937.

DREDGING PLANT AND OPERATION

All the extensive floating plant was constructed at Fort Peck with the exception of the launches and the towboat, which have steel hulls. The dredges are electrically operated, by power from the Montana Power Company at Great Falls, Mont. Coming into the Fort Peck substation at 154,000 v, the current is stepped down to 7,250 and is sent out on feeder lines which are distributed throughout the borrow-pit areas. Each dredge and floating booster carries a reel of 1,000 ft of rubber-covered cable which connects the unit to the feeder line on the bank.

Dredges were designed with ladders of sufficient length to work with the greatest efficiency at depths of 45 ft below the surface of the water. It is possible to dredge as deep as 55 ft, but at lessened efficiency. In actual practice the dredges operate between 25 and 50 ft below the surface, according to the nature of the material.

Depending on the type of material and the depths, the cuts vary from 250 to 350 ft in width. If the dredge is operating against a face where the material caves easily and feeds itself to the cutterhead, correspondingly higher production is obtained. Obviously, the deeper the cut the better the production up to the most economical dredging depth.

During 1935 the dredges operated with a 33-in. suction opening. This year, two of the dredges are provided with the equivalent of a 38-in., one with a 35-in., and the fourth with a 33-in. opening. As soon as the most economical size is determined, the indicated changes will be effected.

MEETING DIFFICULTIES

High vacuums have been attained, sometimes running as much as 24 or 25 in. without breaking. The average vacuum at the present time is about 21 in. When it is remembered that at this altitude the breaking point is 27 in., it can better be appreciated that these vacuums are unusually high.

High pipe-line velocities have been the rule. The average during 1936 has varied from 22 to 25 ft per sec. Measurements by the salt velocity method are taken on every pipe line three times each day, each measurement consisting of 10 individual observations.

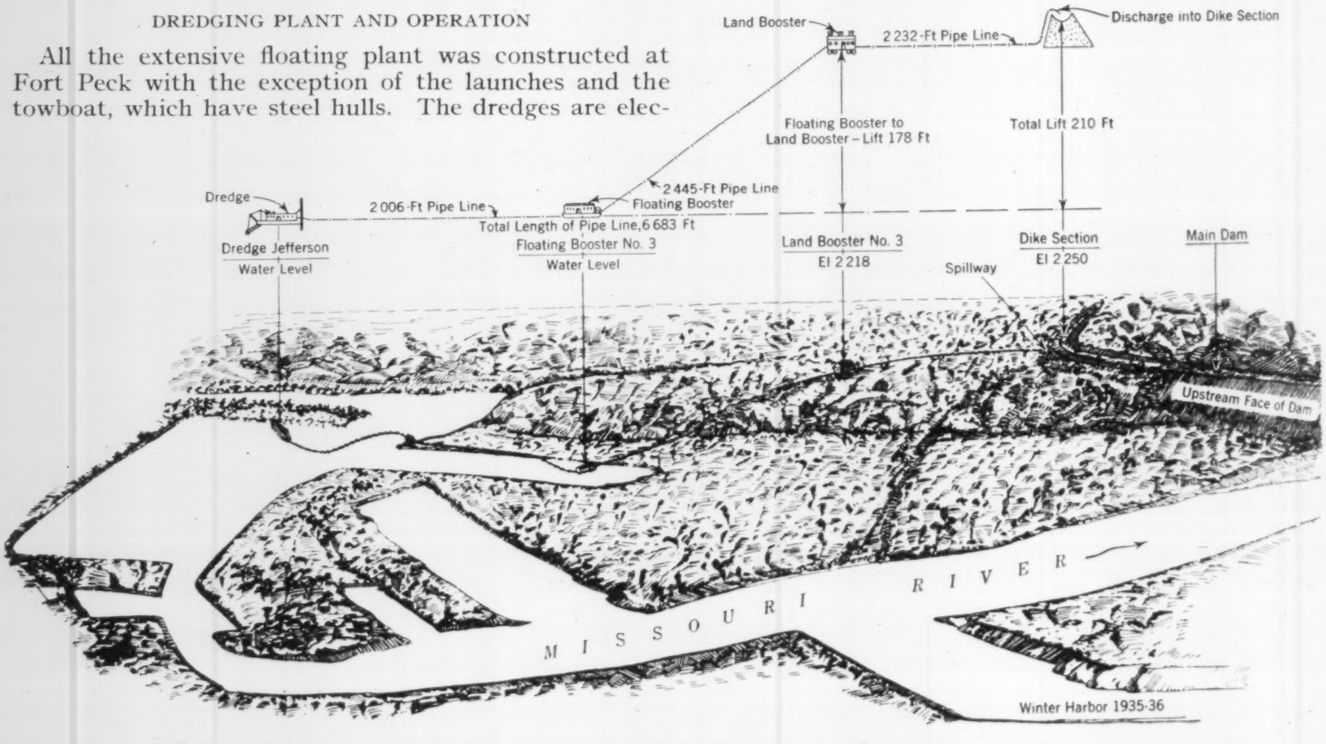

Land Booster
2 232-Ft Pipe Line
Discharge into Dike Section
Floating Booster to Land Booster – Lift 178 Ft
Total Lift 210 Ft
2 445-Ft Pipe Line
Dredge
2 006-Ft Pipe Line
Floating Booster
Total Length of Pipe Line, 6 683 Ft
Dredge Jefferson
Water Level
Floating Booster No. 3
Water Level
Land Booster No. 3
El 2 218
Spillway
Dike Section
El 2 250
Main Dam
Upstream Face of Dam
MISSOURI RIVER
Winter Harbor 1935-36

FIG. 1. SKETCH OF DREDGING PLANT ARRANGEMENT, AS UTILIZED FOR BUILDING THE DIKE SECTION

Each pump will normally build up a pressure of slightly over 60 lb per sq in. Therefore, the discharge pressure at the dredge is approximately 115 lb, and at least this amount at the floating booster. Discharge pressure at the floating booster is dependent on the pipe-line distance from the dredge. Early experience showed that dangerously high pressures, sometimes exceeding 300 lb per sq in., were created when the vacuum was broken and slugs appeared in the lines. Excessive leaks developed at the joints, a few pipes burst, and one floating booster was sunk owing to the pulling out of the slip-joint between Nos. 3 and 4 pumps.

A number of devices have now been developed and installed which practically eliminate these early difficulties. A butterfly valve on the suction line a short distance behind the cutterhead, actuated by air and controlled by the dredge runner, is most effective. When the dredge runner sees the vacuum on the gage climbing dangerously near the breaking point, he opens the valve, a flow of water is admitted to the suction, and the vacuum drops immediately. The butterfly valve is then closed, and normal operation ensues. At the floating booster a fuse plug, in the form of a thin sheet-metal diaphragm, is set across the opening of a 6-in. pipe in such a manner that it will blow out at about 300-lb pressure. Also, at the floating booster, a hand valve is installed which is operated when the gages indicate that a slug is approaching. This valve admits air to relieve the vacuum or allows the escape of the trapped air when the pumps are started up, thus cutting down dangerous pressures.

During the 1935 dredging season, the average lift was about 45 ft for all dredges. As the dam increases in height, obviously this lift will increase also. This year, the dike section of the dam is being placed hydraulically with a maximum lift of over 240 ft (Fig. 1). To my knowledge such an extremely high lift is without parallel in dredging operations of this magnitude. This experience will be of great value in the building of the higher portion of the main embankment.

All pumps in use on the dredges are identical 28-in., centrifugal, cast-steel machines. The nature of the material and the continuous operation have resulted in excessive wear. During the 1935 season it was necessary to replace pumps every three weeks. This year certain modifications have extended this time to about four weeks. Maximum wear occurs on the shoulders of the shells, on the liners, and on the outside edges of the impellers.

Modern welding technique has been extensively applied for the rebuilding of dredging equipment. The largest jobs handled are the rebuilding of worn dredge pumps, hard-surfacing and rebuilding of cutterheads, and the repair of spuds. By means of ingenious jigs developed on the job, large pieces such as pump shells, impellers, and cutterheads are mounted in positions where welding is most easily and quickly performed. The extent of the welding operations is best indicated by the consumption of welding rod, which averages three tons per week. Forty complete pumps are on hand. By careful planning and the elimination of waste motion, pump changes for one complete dredging unit have been effected in less than seven hours.

Rapid and sure communication between the various dredging units and the fill is a necessity. A party telephone line is provided for each unit, and is connected into the main telephone system at Fort Peck. In the event that this fails, a system of visual signals has been developed. At night, colored lights are utilized. Recently, during an electrical storm, when the telephone circuits were temporarily out of order, one dredge unit was operated for several hours by this visual system.

PIPE LINES AND FILL PLACEMENT

Over 110,000 ft of discharge pipe is used, varying from $^{3}/_{4}$-in. flanged pipe, 28 in. in diameter (for floating line and land line), to $^{1}/_{4}$-in. ball-and-cone pipe, 16 in. in diameter (for fill-line pipe). Wear on the land lines is not excessive, since these lines are laid very carefully to grade. It is planned to rotate each section of 28-in. pipe, $^{3}/_{4}$ in. thick, one-quarter turn each year so that the lines will be certain to last for the entire dredging period. Maximum wear in one season has been $^{1}/_{4}$ in. Elbows of course show greater wear than the straight lengths of pipe and have to be replaced occasionally.

This Floating Booster Receives Pumpage from the Dredge and Sends It Forward to a Land Booster by Means of Tandem Centrifugal Pumps Totaling 5,000 Hp

The heavy 28-in. flanged-type discharge lines are carried up on the fill as far as possible, being so placed that frequent moves are not required. From there, lighter ball-and-cone pipe lines are carried along the beaches. Lifts of fill pipes average 6 ft, temporary trestles being built as each lift is put into place. When dredging commenced, retaining dikes were essential for each lift inasmuch as the fill could not be placed directly against the gravel toes. As the fill was built up and the entire base of the dam could receive fill, the dikes were abandoned in favor of the use of "shutter," or as it is sometimes called, "pocket" pipe. Each $12^{1}/_{2}$-ft section of ball-and-cone pipe is equipped with one pocket or opening 6 in. by 12 in. in area. It has been found that one dredge will discharge over a length of from 450 to 900 ft, or 35 to 70 pockets, leaving no discharge for the end. These pockets are closed by sliding metal shutters.

To prevent excessive erosion of the abutments and to fan out the water at spots along the beaches, cutting down the velocity and forcing the water to drop its load of material, shear or baffle boards are used. To break up the velocity of the stream and to spread the fill at the ends of the discharge pipes, timber tables are utilized.

On dredging projects in the past a loss of head due to pipe-line friction was expected to be 6 to 7 ft per 100 ft of pipe. At Fort Peck, by careful placing and leveling of the land lines, the friction loss of head has been reduced below previous experience.

CONTROLLING HYDRAULIC FILL

Cascade spillways with pile foundations at the river ends of the fills are used for the discharge of the dredging effluent water. The temporary dam sections on the flood plain on either side of the river had to be designed with plugs of stable material to retain the core pools and the partially consolidated core material. To insure a stable plug, more sand than that present in the normal core material is being placed, and the sheet-pile cut-off wall is being extended up through these plugs and into the impervious core material in order to prevent excessive seepage later, through the plugs.

In designing the core, both the grain-size limits and the physical dimensions of the core material are of primary importance. Factors governing the type of material used in the core are stability and permeability. Therefore the location of the coarse limit was governed by the allowable permeability coefficient, which determines the position of the saturation line in the downstream shell and the total volume of seepage. Location of the fine limit was governed by the estimated rate of consolidation, which is a function of the stability.

PIPE LINE DISCHARGING INTO CORE POOL
Each Section of Pipe Has a "Pocket" Opening in the Bottom

It is undesirable that any large amount of material be placed in the core which contains more clay than is shown by the fine limit, since the consolidation would be very slow owing to the high-clay content. In this case only a small proportion of the ultimate consolidation would be taken up during construction; therefore the consolidation of the core would continue over a long period at a rate which might be detrimental to the completed structure.

On the main dam, the upstream slope of 1 on $^{2}/_{3}$ adopted for the core was governed by the slope of the upstream shell. This was considered the maximum core slope which the upstream shell could retain with an adequate degree of safety. The minimum downstream core slope was also set at 1 on $^{2}/_{3}$, but the flatter downstream shell slope permitted the use of a maximum core slope of 1 on $1^{1}/_{3}$, without reducing the stability of the structure.

Soundings in the core pool are made with a light disk in order to determine the depths to the soupy, unconsolidated clays, and with an ordinary heavy sounding lead to obtain the depth to firm material. To July 1, 1936, over 2,000 permanent record samples and over 1,500 control samples had been taken in the core and sand-plug areas.

The two routine tests conducted on core samples are the mechanical analysis test and the moisture-content determination. Numerous tests in the District laboratory have confirmed the use of the effective size as a means of approximating the permeability coefficient, and they have also shown that the clay content is indicative of the shear value (stability) of a given material.

Pool width is controlled by adding or removing boards from the cascade spillways. Velocities in the core pool are determined by floats. The depth of water above the soupy material is only a few feet, but the depth to firm core material ranges from 15 to 20 ft. The amount and nature of material wasted over the spillways are determined from the analysis of jar samples taken three times daily at each spillway.

The allowance for subsidence and shrinkage of the fill has been based on consolidation tests made on foundation materials and on actual field data obtained during early stages of construction. A tentative allowance for subsidence and shrinkage has been set at 5 per cent in the central portions of the dam above the clay beds, and at 2 per cent near the abutments, where the foundation consists mostly of sand. This may be varied slightly during later stages of construction, depending on the data obtained from the settlement plates.

SOME OPERATING STATISTICS

On October 11, 1934, the first dredged material poured into the Fort Peck Dam. Only one dredge unit went into action at that time, the other three units not yet having been launched. During the period October 11 to December 23, 1934, inclusive, 843,300 cu yd of fill were placed.

It was mid-April, 1935, before the river was free of ice. All four dredges were then moved upstream and operated continuously until severe weather closed the river on October 31. In the $6^{1}/_{2}$-month season 25,259,360 cu yd were pumped, of which 20,898,700 (82.7 per cent) were retained in the fill.

This year (1936) it was again mid-April before operations could commence. The starting date would have been even later had not vigorous measures been taken to break up and remove the ice. From this experience an earlier start does not appear probable and a dredging season of more than 7 months at Fort Peck is unlikely. Progress for 1936 has been most satisfactory. Up to June 30, 11,151,970 cu yd had been pumped, of which 9,422,500 cu yd (84.5 per cent) were retained in the fill. Total yardage pumped to date is 37,493,970, of which 31,164,500 cu yd (83.1 per cent) have been retained.

Comparative statistics have been compiled for 1935 and for 1936 to June 30, and are presented in Table I.

TABLE I. PROGRESS IN HYDRAULIC-FILL OPERATIONS

ITEM	1935	1936 (to JUNE 30)	1935 & 1936 COMBINED
Average advance in borrow pit per day, in ft	76	98	81
Average width of cut, in ft	329	277	321
Average depth of cut, in ft	34	37	35
Effective dredge-hours (total of all dredges)	15,512	6,312	21,824
Effective time in percentage of total time dredges are in operation	81.3	85.3	82.4
Hours per day per dredge	20.14	20.87	20.35
Total output per hour, in cu yd	1,628	1,767	1,662
Average pipe-line velocity, in ft per sec	21.2	23.3	21.7
Average length of pipe line, in ft	10,105	11,385	10,425
Vacuum, in inches of Hg (average)	21.4	20.2	21.1
Power required, in kwhr per cu yd	3.85	5.45	4.22

Difficulties there have been, but improvisation where necessary and unusual ingenuity displayed by the operating forces have enabled steady progress to be made. It is believed that all major problems have been solved and that no obstacles will intervene to prevent the orderly completion of the dam in 1939, as planned.

Planning and design of all features of the project have been performed in the Missouri River Division office of the Army Engineers at Kansas City, Mo., with Col. R. C. Moore, Corps of Engineers, as division engineer. Responsibility for the construction is placed on the Fort Peck District, with the writer as district engineer.

Facts and Figures About Irrigation

Watering of Arid and Semi-Arid Lands in the West Attains Increased Importance

AT the meeting of the Society's Irrigation Division in Portland, Ore., held on July 16, 1936, as a part of the Sixty-Sixth Annual Convention, contributions to the general fund of information about the present status and future possibilities of irrigation in the West were presented in two papers which are here abstracted for the use of members.

In the first article, Mr. Haw emphasizes the importance of reclaiming arid land by irrigation as a part of current policies and programs for the use of natural resources. Increase of population, particularly in the West, will require more acreage for food and fiber crops, which can only come from reclaiming arid land. Irrigation west of the continental divide will provide space, employment, and opportunity for the unfortunate residents of the "dust bowl" in the great plains region. The seasonal grazing of livestock is also dependent upon irrigated river valleys. In addition, the water-storage projects which are necessary to carry on irrigation development often prevent flood damage, aid navigation, provide power, and stimulate industrial development in general.

The paper by Mr. Goodwin is concerned only with irrigation west of the Cascade Mountains in Oregon and Washington, embracing the narrow coastal plains, the large river valleys, and especially the Willamette Valley drainage basin. While precipitation in this area is not deficient on a yearly basis, it is very small during the growing season, so that applications for irrigation water rights have shown a steady increase. Experiments in providing even a small amount of irrigation water in this area have produced an increase in general crop yield of over 50 per cent. Studies now being made by the U. S. Army Engineers indicate that 94 per cent of the 660,000 acres on the floor of the Willamette Valley could be served by gravity supplies from about forty possible flood-control reservoirs.

Irrigation and the Land-Use Program

By John W. Haw

Director of Agricultural Development, Northern Pacific Railway Company, St. Paul, Minn.

IT is certain that the future of the western states will be largely influenced by the policies and programs now taking shape relative to the use of land and water resources. In the well-intentioned zeal of certain individuals and groups for production control and acreage reduction, a war is being waged against reclamation, particularly arid-land reclamation. If, through a study of the underlying facts in land use, this attitude can be tempered by justice and reason, the West has cause to be thankful to those who initiated the land-planning program.

At each of the recent national conventions of our major political parties, strong pressure was brought for inclusion of the following platform plank: "We oppose the use of federal funds for new irrigation and drainage projects which compete with cultivated farm lands while a surplus of farm products exists." The sponsors of the proposed plank included leaders of national farm organizations as well as prominent Eastern and Middle Western political leaders. It failed of adoption by a narrow margin.

An Irrigated Sugar Beet Field, a Part of the Minnidoka Project in Idaho

National Sugar Consumption Has Increased from 78 to 100 Lb per Capita

This phrase, with minor variations, represents what appears to be the considered opinion of many important groups of American citizens. But it is not a considered opinion. Its exponents have obviously made no thorough study of the whole complex question of a sound national land-use program and the place of reclamation in such program. If these views are not to become a controlling national policy, the time has arrived when they must be met. Reliance upon political strategy will not suffice.

RECLAMATION HAS ENCOUNTERED PROBLEMS

Undoubtedly some of the opposition to reclamation has been brought about by faults in the handling of financial and administrative problems. Such problems are not so easily divorced from politics as are technical engineering problems. It was but natural for the personnel of the Bureau of Reclamation to become increasingly engrossed in the more fascinating engineering problems, while the knotty questions of economics, management, and debt collection, loaded in many instances with political dynamite, were neglected.

The most severe critics of irrigation have never found any major fault or taint of graft in the engineering features of federal project construction. However, the delivery of 3 acre-ft of water to the high point on each farm unit is the beginning rather than the end of reclamation. There remain the questions of settlement, sound farm development, efficient project management, and the troublesome financial problem of meeting cost of operation, maintenance, and repayment of the construction debt.

IRRIGATION DEVELOPMENT IN THE WEST PROVIDES SPECIALTY FOOD SUPPLIES

A Date Orchard on the Yuma Project in Arizona

The late Elwood Mead, M. Am. Soc. C.E., Commissioner of Reclamation, made a beginning toward sounder and more businesslike administration. Acting Commissioner J. C. Page and Chief Engineer R. F. Walter, M. Am. Soc. C.E., are continuing the work. Toleration by the people of the West of the situation just discussed is the real explanation of the disrepute into which reclamation has fallen in some quarters.

Should there be any new land developed in this country? If so, how will the 11 western states be concerned? Obviously, in the answer to these questions lies the future of irrigation development.

The concept of land-use programs, either regional or national, is recent.

It is unfortunate that reclamation by irrigation has come to be thought of as having a status apart from the general welfare of the whole country. To be sure, it has rights attaching particularly to the western region, but nevertheless its uses are inseparably intertwined with broad national considerations.

Dim perceptions of a national interest in land use were expressed in the Homestead Act, its successors, and various irrigation acts which culminated in the Reclamation Act of 1902. The latter provided that revenues from the sale, lease, and royalties from public lands and minerals in the western states should be segregated and loaned interest-free, for the construction of irrigation projects. Because of this provision, a conviction unfortunately grew up that reclamation was a matter primarily of regional concern. Strictly speaking, this was never true, and present plans to articulate further reclamation into a program of sound national land use constitute a belated recognition of factors which actually were present from the outset.

THE WEST SHOULD BE SELF-SUSTAINING

Reasonable self-support as to agricultural commodities applies as much to a region as to a nation. Particularly is this true of bulky staple foods which must be provided regularly in large quantities and which constitute the main article of diet for laboring people. The smaller nations of Europe have recognized that, aside from national defense, adequate supplies of such foodstuffs, reasonably priced, are foundations of health and contentment, stable industrial activity, and political tranquillity.

The West is as isolated geographically from the rest of this country as the nations of Europe are from their raw materials and staple foodstuffs, an isolation brought about by the 1,000-mile width of the Great Plains, coupled with the rough Continental Divide. Obviously unavoidable transportation costs, which in effect are import and export duties, must be assessed against the interchange of products with the remainder of the nation. Regardless of this, the West will continue to supply eastern markets with products which cannot be produced seasonably, at low cost, or of high quality, in the Middle West or East. Staple food products from the humid regions will continue to flow westward as consumptive demand outruns the West's ability to produce them. Western populous areas must become resigned to higher price levels on staples; yet can they not fairly urge reasonable development of their resources to check the growing need for importing these?

Exchange of some farm products is inevitable and desirable. The 11 western states are now the best customers of the Mississippi Valley corn and hog farmer. No possible land development is in prospect which will alter the trend toward an increasing western movement of pork products, corn, butter, dairy stock, and other farm products of the Middle West.

THE WEST IS ADAPTED TO PRODUCE SPECIALTY FOODS

Irrigation development in the West has a very definite place in the provision of adequate specialty food supplies for the entire nation. This area now makes a large contribution of food products which no other region is climatically adapted to produce, particularly fresh vegetables out of season, canned vegetables, fresh and canned fruits, nuts, berries, melons, sugar, certain varieties of cotton, wines, and grass seed. Table I, taken from the report on Federal Reclamation, by John W. Haw and F. E. Schmitt, M. Am. Soc. C.E., to the Secretary of the Interior, dated December 1, 1934, shows how small is the percentage of staples produced on existing federal reclamation projects. As these commodities come on the markets from nearby areas east of the 100th meridian, shipment from the West ceases; therefore the irrigated lands of the West cannot be considered as competing with cultivated lands in other sections with regard to even these specialty food products.

TABLE I. SUMMARY OF CROPS ON FEDERAL RECLAMATION PROJECTS FOR THE SEASON OF 1933

CROP	ACREAGE	VALUE	PER CENT
Cereals	356,922	$ 4,503,898	9.2
Seeds	34,819	562,554	1.2
Hay and forage	1,211,148	13,637,431	27.9
Vegetables and truck	142,916	10,326,843	21.2
Fruits and nuts	57,095	5,406,141	11.1
Sugar beets	110,008	6,575,616	13.5
Cotton	147,507	7,397,420	15.2
Miscellaneous	15,411	355,960	0.7
Gross total	2,075,826	$48,765,863	100.0

Certain very definite changes are taking place in the dietary habits of the American people, and these should be taken into account in future programs of land use. For instance, the domestic use of wheat flour has declined 17 per cent in the past 15 years. Cereal foods as a whole have declined from a per capita per year consumption of 330 lb in 1910, to 240 lb in recent years. Consumption of animal products has increased about 5 per cent, although meat alone has shown little change, and dairy products, eggs, and poultry show a noticeable rise. While total fruit consumption has remained practically stationary, there has been a rapid rise in the use of citrus fruits, pears, plums, prunes, and grapes, for the most part at the expense of apples. Sugar consumption has risen in twenty years from 78 lb per capita to from 95 to 100 lb. There has been a marked increase in the consumption of vegetables other than potatoes during recent years.

In view of these trends it is preposterous to assume that land development should take place uniformly over the entire country. Those lands must be brought into use which are particularly endowed by soil and climate to produce those articles of food and clothing which we will demand in the future. Practically all diet studies point to the fact that consumption of those specialty products which the West is fitted by nature to produce is on the increase.

Not only will consumption of western products increase per capita, but there will be a further expanding market in our increasing population. Recent estimates indicate a population in continental United States of 131 million in 1940, 138 million in 1950, and 141 million in 1960. On the basis of a moderate-cost diet, the crop area must be increased from 270 million acres in 1935, to 286 million in 1940; in 1950 to 301 million acres; and in 1960 to 310 million acres. Considering now a few commodities supplied in large measure by the West, authorities estimate that in 25 years we will require approximately 800,000 additional acres of fruit, 2,000,000 additional acres of vegetables, 300,000 additional acres of sugar cane or sugar beets, and 20,000,000 acres of feed and pasture for livestock.

The West is bound to share in the increased population of this nation. Its rate of growth from 1920 to 1930 was more than double the rate for the nation as a whole, and it will probably continue to outstrip other sections of the country. Not only will there be growth by reason of excess of births over deaths, but it is a mecca of migration from other sections of the country. By migration alone the western states will have substantial additions to their populations of people past middle age, semi-invalids, and those seeking a location amid comfortable living conditions. Regionally, the West will have an increasingly pressing problem in feeding and clothing its own people. The increase in population on farms and towns of the federal reclamation projects and the financial investment are shown diagrammatically in Fig. 1, taken from the previously mentioned report on federal reclamation by Messrs. Haw and Schmitt.

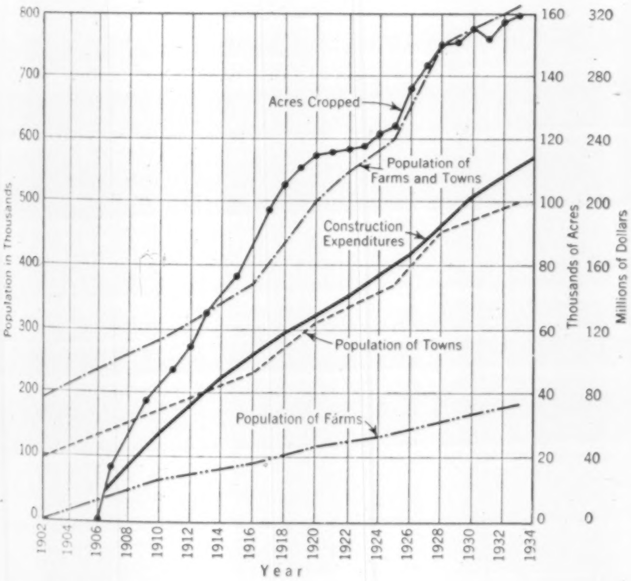


Fig. 1. Reclamation Developed New Population in Proportion to the Investment Made

EXPANSION POSSIBLE ONLY BY USE OF ARID LANDS

In connection with feeding their own people and providing specialty food products for the nation, it must be remembered that in general, farm production other than extensive wheat and livestock operations in the 11 western states is now confined largely to irrigated lands. Exceptions are the dry-farmed lands in Montana, Wyoming, Colorado, Idaho, Washington, and Oregon, and the cut-over areas of western Montana, northern Idaho, western Oregon, and Washington. It seems practically certain that production will continue to decline on dry-farmed lands because of recurring droughts, wind erosion, and depletion of soil fertility. Some slight expansion is possible in the cut-over areas, but such lands lend themselves best to subsistence farming, and their areas are limited.

A Hop-Picking Scene in the Yakima Valley, Wash.
With Irrigation, Arid Lands Become Highly Productive

Accordingly, in the 11 western states, comprising 40 per cent of the continental United States, any further expansion of commercial farm production worth mentioning must come about through the application of surplus stream flow to arid land. Between 1919 and 1929, irrigated land increased only 355,828 acres, that is, from 19,191,716 to 19,547,544 acres for all states in which this type of farming is practiced. Figures for the period 1930–1935 are not available, but most observers agree that the western territory as a whole has shown no expansion of irrigated areas in the past five years.

Figures from the 1935 census in the 11 western states show an increase in five years of 67,912 farms, but a decrease in the acreage available for crops of 4,016,034 acres. In other words, the land available for crops does not seem capable of ready expansion in this region, and the addition of more farmers merely signifies a subdivision of existing farms. These figures certainly indicate that agricultural production for commerce in the western states has definitely decreased. While this may not hold true as to isolated commodities, it is true in the aggregate.

RANGE LANDS DEPEND ON ADJACENT IRRIGATED LANDS

Reclamation of land by irrigation cannot be separated from a consideration of the use of the vast lands in the

MONTANA RANGE SHEEP BROUGHT DOWN TO THE IRRIGATED BOTTOM LANDS

western states suitable only for seasonal grazing of livestock. In this area are produced 55 per cent of our sheep and lambs, 33 per cent of our cattle and calves, and 75 per cent of our wool and mohair. The western ranges, with adjacent areas of irrigated land, produce unfinished lambs and cattle for the Middle Western farmer to fatten for market. In the livestock business the West is complementary to, not competitive with, the Middle West. If this relationship were disturbed, both areas would suffer. The consumer of beef, lamb, and wool would also be hurt if this dual production arrangement were prohibited or limited.

The grazing ranges could be used only to a limited extent were it not for irrigated land in river bottoms within practical trailing or shipping distance. In practically all these states there is a demand for additional irrigation, solely for the production of winter feed. The Casper-Alcova project, now under construction in Wyoming, will provide feed insurance against summer droughts and severe winters for the livestock industry in a large area of that state. The Buffalo Rapids project in Montana, at present under investigation, will be a similar protection to the range livestock industry of southeastern Montana. At present these areas are subjected to dry years when herds and flocks must be sharply curtailed either by shipping to market or transporting over long distances to adequate range at terrific loss to range operators and with an economic loss to the nation.

The irrigation of fertile bottom land for the production of a feed backlog for the range livestock industry is a problem in land use of national significance, because the consumer of the resulting product is the man on the street the nation over. Prospective requirements for meat animals and wool dictate a policy of preserving our present livestock industry in a thrifty condition both on ranges and farms; in fact, moderate expansion seems to be indicated.

IRRIGATION WILL SOLVE THE GREAT PLAINS PROBLEM

An analysis of future land use in the western states is not complete without discussion of the farm population shifts which apparently will be necessary because of the unwise direction of settlement and over-development of the Great Plains in the homestead period, and the later extension of the crop area under the stimulus of high wheat prices during the World War.

There are wide differences of opinion as to the highest use for the semi-arid lands which lie between the foothills of the main range of the Continental Divide and the 100th meridian. The 1930 census shows 312,003 farms in this area. I believe that the recent dry years are not typical of the area, and that the abundant rainfall from 1910 to 1918 was not typical either. Farming will in time evolve agricultural practices that will bring about land use for the highest possible production, here as elsewhere. I am far from willing to "quit-claim" the Great Plains to the Indians. The area is now serviced by thousands of urban communities, and any sudden, sweeping abandonment would bring economic dislocation of the most serious character to farmers, business men, and professional men alike. Nationally it would be most unwholesome to have a 1,000-mile strip of desert through the heart of our country.

I do not believe that anyone is gifted with sufficient foresight at the present time to mark out the grazing areas, the semi-ranch areas, and the large-scale grain-farming areas. Trial and error will have to fix the final boundaries. This method is gradual and has the advantage of being imposed by natural law rather than government edict.

The shakedown can best be brought about by gradual withdrawal of some types of relief. The area is now frozen in uneconomic farm-management practices by the perennial relief programs of the past ten or fifteen years. By a conservative estimate, 50,000 to 75,000 farm families must pack up the truck during the next ten to twenty years and go over the hill in search of another location.

Where will farm opportunities exist for these Great Plains drought veterans? If not in safe and tried farm communities, where can opportunities for them be created with the greatest future benefit to the nation and with the least disruption to established agriculture? The chances are that yearly for the next 20 years, 2,000 to 3,000 farm families must be absorbed into some area. Only new western irrigation projects appear to provide this opportunity. The Gila, Coachella, Central Valley, Casper-Alcova, Deschutes, and Columbia Basin projects will gradually come under irrigation if construction is continued coincident with western migration.

MALADJUSTMENT, NOT SURPLUSES, IS THE PROBLEM

I have never felt that any arbitrary sweeping program of retiring productive land was either necessary or desirable. Remember one always travels with the wind in reducing farm production and taking land out of cultivation. Drought, wind, water, insects, plant diseases, and weeds put a strong draft behind even a weak effort at production curtailment. Furthermore, striving for high production on a farm is laborious. If 6,000,000 farmers ease back in the harness for a few years, the fondest hopes for production curtailment will be realized.

If agriculture is destined for sweeping general reduction, the West rightly should be asked to go along with the national program. But it is utterly unsound economics to blanket the supply and demand of all food and fiber products. In normal times we import four-fifths of our sugar and one-half of our wool, yet we need to export cotton, corn, tobacco, and lard. Why not treat the problem, commodity by commodity, selectively? Adjustment of production between commodities is a goal worth striving to attain.

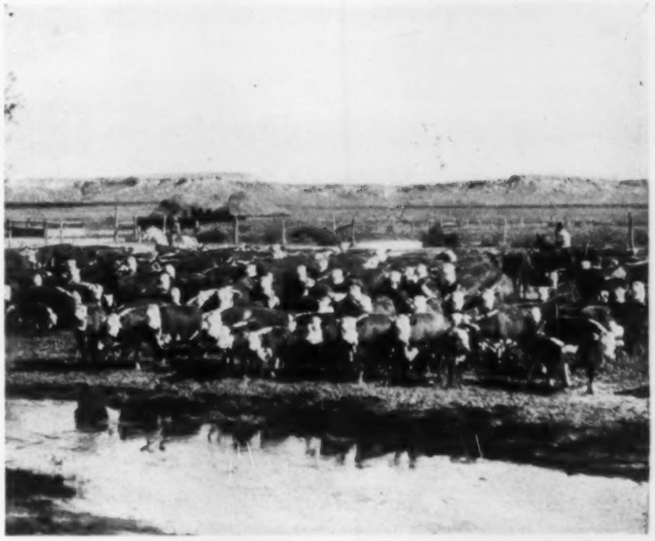
But even on a basis which brackets all commodities, are we certain that this country grows a surplus of food and fibers? The statistics do not bear out any such conclusion. We are now importing agricultural commodities in greater volume than we are exporting, and the trend is to go further in that direction. The figures show that in competitive agricultural products, the balance of trade turned against the United States in 1933 to the extent of $77,434,000; in 1934, $97,147,000; and in 1935, $275,540,000. Recognized authorities estimate that imports of agricultural character last year amounted to approximately one and one-half billion dollars. Even after the elimination of such tropical products as coffee, tea, spices, and rubber, we still imported 1.2 billion dollars worth of products which could have been produced in the wide range of climatic and soil conditions which exist in this country. Favorable trade balances brought about by our imports are now commonly used for the purchase of bargain-counter securities, armaments, and materials of war—not for wheat, meat, cotton, tobacco, and industrial products.

With consumption at low ebb, with a steadily increasing population, with land declining in fertility, and millions of acres lost annually through natural forces impossible to combat, with important new industrial uses for agricultural products just around the corner, and with the possibility of recapture of American markets for American farmers, it is a tragic mistake in national policy to curtail our entire agricultural industry. Agricultural adjustment should really adjust. It should contract production of certain commodities in certain areas and expand production where such is desirable.

FUTURE FOOD REQUIREMENTS SHOULD CONTROL IRRIGATION DEVELOPMENT

The place of arid-land reclamation in a program of sound national land use should be based on the future rather than the present. Maturity of production does not occur for many years after the physical works of a project are completed. In the case of large projects, from 15 to 25 years are required, after water is available, to mature a full farm-production program.

The integrating of new irrigated land into a land-use program must be projected ahead into the regional and national food requirements 20 to 25 years hence. For instance, if the full Columbia Basin development, an ultimate 1,200,000-acre project, were authorized today and funds appropriated, irrigation water for the first 50,000-acre unit could not be made available before 1940. This unit would not be fully settled before 1945 and would not make substantial contributions of farm products beyond project borders before 1950. Perspective is absolutely essential to sound conclusions on the desirability of reclaiming desert lands by irrigation.



Western Land Irrigation Plays an Important Part in Range Utilization and Thus in the Livestock Industry

In conclusion, water storage, primarily for irrigation, is indirectly connected with almost every factor which concerns the economic life of this western country. Most projects now under construction, and certainly those for the future, are very definitely multiple-purpose projects, providing power and municipal water supplies, stimulating industrial development, preventing flood damage, and in some locations enhancing the opportunity for river navigation.

Benefits of Irrigation West of the Cascades

By George E. Goodwin

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IRRIGATION in some crude form and to some small extent must have been practiced by human dwellers in arid regions for many thousands of years, and its development grew with the wisdom and number of such peoples. Archeologists inform us that in our Southwest and in Mexico and Peru there are traces of irrigation systems that possibly antedate the larger developments in the valley of the Nile over 4,000 years ago. Contemporaneous irrigation systems probably existed in Asia, notably in the countries now known as Irak, India, and China. From Egypt the practice of irrigation spread to Phoenicia, Greece, and Rome, and later to Spain, which country is the mother of the art of irrigation as now practiced in over two dozen different countries to the extent of over two hundred million acres. Over half of this irrigated area is in Asia and more than twenty million acres are in the United States.

Irrigation, as I see it, is the art of applying water to growing crops by artificial means, at such times and in such manner and amounts as to produce the best crops with minimum damage to the lands affected by such application. When irrigation is thus practiced it becomes a real art, and is of great agricultural benefit in regions having climatological, soil, and topographical conditions such as exist in western Oregon and Washington.

Western Oregon and Washington are generally understood to extend from the Cascade Mountains on the east to the Pacific Ocean. However, my remarks are concerned only with the narrow coastal plain, and more especially the larger river valleys embraced within these limits, where agriculture has been practiced for many years. Western Oregon and Washington is an area supplied with many small streams and mighty rivers; it is clothed with natural verdure and is rightly considered one of the wettest parts of the continental United States. To many, irrigation in this area would seem unnecessary, and in fact, it is essentially of the supplemental type,

Third Cutting of Alfalfa on Irrigated Land Raises Total Yield to 9 Tons per Acre

being in general needed only to relieve moisture shortage for a part of the crop-growing period.

While the annual precipitation in the mountain ranges at times exceeds 125 in. (partly snowfall) and at certain places on the coast is nearly as great, most of this precipitation occurs during the fall, winter, and spring seasons. In the large interior valleys the rainfall is very much less, varying in Oregon from about 18 in. in the Rogue River valley and 29 in. in the Umpqua Valley, to 40 in. in the Willamette Valley, and in Washington from about 27 in. in the northern valleys to 36 in. in the southern valleys. In all these areas there is usually a deficiency of moisture during the months of June, July, and August. Using the Willamette Valley as an illustration, the average rainfall during the growing season, from May to October inclusive, is about $9^1/_4$ in., with only about $2^1/_2$ in. between June 10 and September 20. This last amount is entirely inadequate for full yield in crop production, and prevents the growing of certain crops. In these valleys the rainfall in July and August is less than at Fort Collins, Colo., and El Paso, Tex., and about the same as at Logan, Utah, and Phoenix, Ariz.—all considered arid sections, where irrigation is indispensable to crop production.

The water requirement for a full yield of the crops grown in the Willamette Valley varies from about 36 in. for alfalfa, Ladino clover, and other hay and pasture crops, to as little as about 8 in. for potatoes. Here, in general, there is sufficient rainfall and residual moisture left in the soil for the growth of most crops until about the tenth of June. The amount of moisture stored in the soil for plant use is limited by the depth of the feeding-root system and the storage capacity of the soil considered. Aside from orchard and nut trees, which under favorable soil conditions may extend their roots several feet below the surface, the feeding roots of ordinary farm crops extend only to relatively shallow depths, generally not more than 12 in. In old stands of alfalfa the tap roots may go down as deep as 15 ft, but at least 50 per cent of the feeder roots are within the top 2 ft.

Experiments indicate that the useful water-storage capacity of our soils is about $1^1/_2$ to 2 in. per ft of soil depth. As the moisture stored in the upper 2 ft of soil only is available for average crop production, such storage would amount to about $3^1/_2$ in. Taking into account evaporation and the other land losses, and considering that a large part of our irrigated crops are, and will be, alfalfa, Ladino clover, and other hay and pasture crops, it may be stated that an average crop will require about 20 in. of moisture between June 10 and September 20. There is, therefore, in the Willamette Valley a deficiency of 14 in. of moisture after credit has been given for $2^1/_2$ in. of rainfall and $3^1/_2$ in. of residual ground storage.

EXPERIMENTS SHOW VALUE OF IRRIGATION

Extensive field experiments with the irrigation of crops commonly raised in the Willamette Valley were conducted by W. L. Powers, of Oregon Agricultural College, over periods of from 6 to 26 years. These experiments indicate an increase of about 51.7 per cent in general crop yield due to irrigation. In these experiments, the amount of water applied to the crops was very small. Heavier or more frequent applications of water would probably have increased the percentage of yield. Some of the results are shown in Table I.

The increase in crop growth with irrigation, as determined by Dr. Powers, has been borne out in general by field experiments made in western Washington, and to an even greater extent by others made in the southwestern part of Oregon, where the rainfall is less. The results have also been fully borne out in all sections of western Oregon and Washington where irrigation has been practiced on farms in a proper manner.

The Willamette Valley drainage basin is about 230 miles long by 85 miles wide, and embraces about 11,200 sq miles, approximately 1,000 sq miles less than the area of the state of Maryland. The floor of this valley, extending from Cottage Grove on the south to Portland on the north, is 140 miles long, varies in width up to 20 miles, and contains more than a million acres. That a large part of this valley floor is not now irrigated is due to several retarding conditions, the more important of which are the following:

1. The long mild growing season and fertility of the

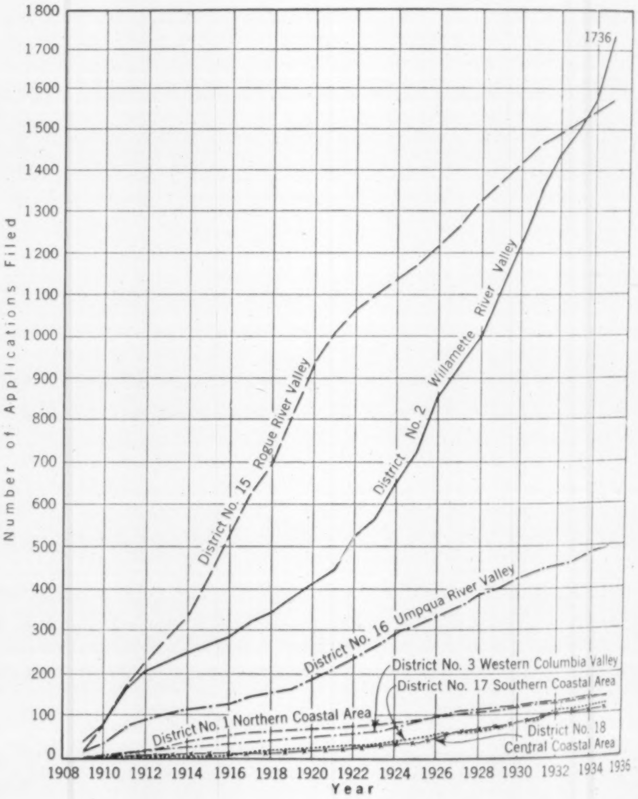

Fig. 1. Increase, by Years, in Number of Irrigation Applications in Western Oregon

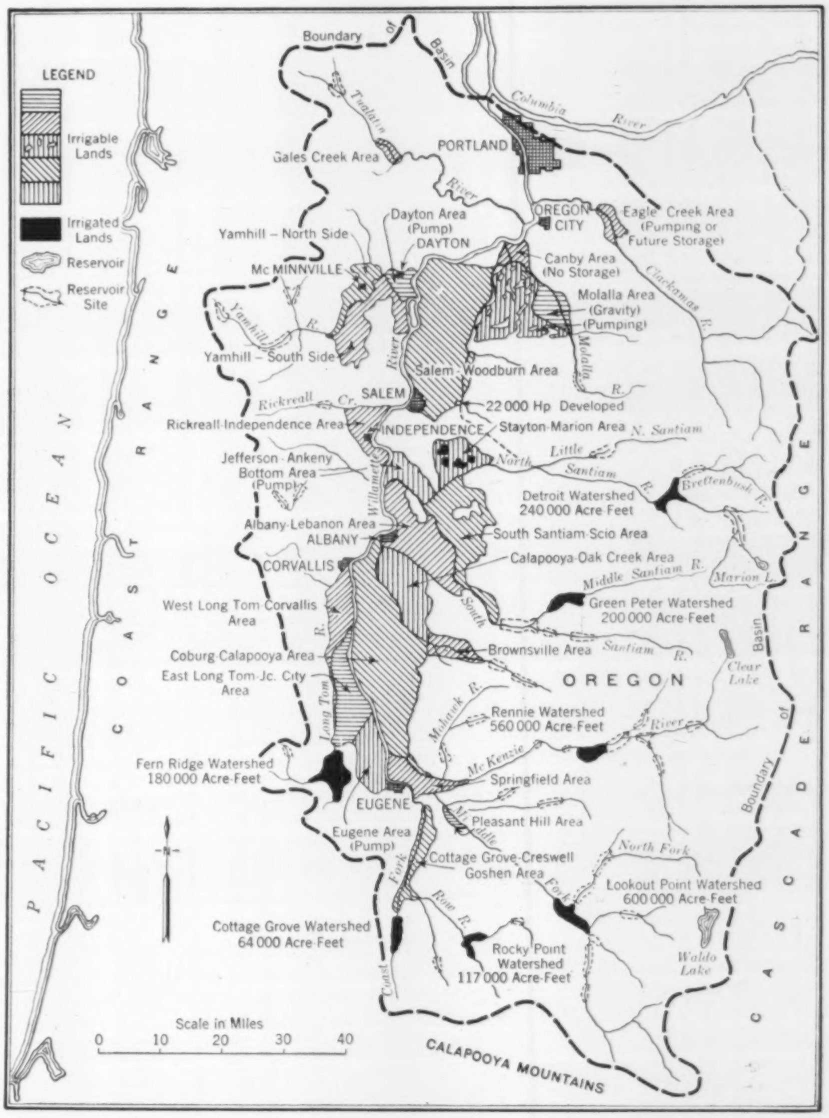
LEGEND
Irrigable Lands
Irrigated Lands
Reservoir
Reservoir Site
Boundary of Basin
Columbia River
Tualatin River
PORTLAND
Gales Creek Area
OREGON CITY
Eagle Creek Area (Pumping or Future Storage)
Dayton Area (Pump)
DAYTON
Yamhill – North Side
Mc MINNVILLE
Canby Area (No Storage)
Molalla Area (Gravity) (Pumping)
Clackamas R.
Yamhill R.
Yamhill – South Side
Molalla R.
Salem-Woodburn Area
SALEM
Rickreall Cr.
22 000 Hp Developed
Rickreall-Independence Area
INDEPENDENCE
Stayton-Marion Area
N. Santiam
Little North Santiam R.
Breitenbush R.
Jefferson-Ankeny Bottom Area (Pump)
Willamette
Detroit Watershed 240 000 Acre-Feet
Albany-Lebanon Area
ALBANY
South Santiam-Scio Area
Calapooya-Oak Creek Area
CORVALLIS
Middle Santiam R.
Marion L.
West Long Tom-Corvallis Area
Green Peter Watershed 200 000 Acre-Feet
South Santiam R.
Coburg-Calapooya Area
Brownsville Area
East Long Tom-Jc. City Area
OREGON
Clear Lake
Mohawk R.
Long Tom R.
Rennie Watershed 560 000 Acre-Feet
McKenzie River
Fern Ridge Watershed 180 000 Acre-Feet
Springfield Area
EUGENE
Middle Fork
Pleasant Hill Area
Eugene Area (Pump)
North Fork
Cottage Grove-Creswell Goshen Area
Coast Fork
Row R.
Lookout Point Watershed 600 000 Acre-Feet
Cottage Grove Watershed 64 000 Acre-Feet
Rocky Point Watershed 117 000 Acre-Feet
Waldo Lake
N
Scale in Miles
0 10 20 30 40
CALAPOOYA MOUNTAINS
PACIFIC OCEAN
COAST RANGE
CASCADE RANGE

Fig. 2. Map of the Willamette River Valley in Western Oregon, Showing Possible Areas Irrigable by Stored Water

lands usually make it possible for the farmers to raise fair crops without irrigation and with a minimum of labor;

2. It is often difficult to sell the crops now raised at a price sufficient to cover the cost of production;

3. There is insufficient summer stream flow for any new, sizable, irrigation area, and the necessary storage, if for irrigation alone, would be expensive.

4. Thus far, most of the irrigated areas are served by small pumping plants, often pumping from wells requiring considerable lift.

The resulting cost of the plant and operation has made this form of irrigation uneconomical except for the higher-priced farm products, and those that can be raised only by irrigation. The first of these retarding conditions will be changed only when there is a demand for bigger money crops and the present large grain plantings are succeeded by hay, pasture, fruit, and other crops, in small holdings. Improved agricultural conditions may remove the second condition; some system of cheap flood storage will change the third; and the construction of large gravity-irrigation projects having low construction and operating costs will remedy the fourth.

USE OF IRRIGATION IS GROWING

There has been a constant growth of irrigation in western Oregon and Washington, as evidenced by the 4,365 filings for irrigation water rights made in western Oregon from 1909 to date, amounting to 148,000 acres, and the certificates of proof of use of 46,000 acres from 1913 to date. These data are taken from the records of the secretary of the Reclamation Commission.

In Fig. 1 is shown the increase, by years, in the number of irrigation applications in the various water districts of western Oregon. Note the growth of Districts 1, 18, and 17, which are on the coast where the maximum annual rainfall in the state occurs. While most of these filings were for relatively small areas, usually representing an effort to irrigate a small acreage by pumping, they indicate that the farmers are each year becoming more irrigation-minded. The demand for large gravity-irrigation projects is "just around the corner."

Table I. Results of Field Tests on Crop Yield with and Without Irrigation

Crop	Years Trial	Yield per Acre		Average Irrigation	Percentage Gain with Irrigation
		Dry	Irrigated	Inches	
Alfalfa......	24	3.62 tons	5.83 tons	10.50	61.1
Red clover..	25	4.17 tons	6.25 tons	8.15	49.9
Alsike......	19	1.92 tons	4.01 tons	8.44	108.8
Grass.......	10	3.33 tons	5.13 tons	11.20	54.0
Potatoes....	26	134 bu	192.92 bu	4.12	43.9
Beans.......	22	10.32 bu	15.32 bu	3.35	47.6
Corn.......	26	6.47 tons	8.93 tons	5.80	38.0
Kale.......	4	10.61 tons	13.91 tons	4.33	31.5
Beets.......	7	10.98 tons	15.61 tons	4.50	42.2
Fiber flax...	6	1.68 tons	2.36 tons	4.00	40.4

Average irrigation...... 6.44 in. Average gain with irrigation...51.7%

Note: These results were on field experimental plats, and the irrigation requirements were determined from wilt tests. Actual farm irrigation would have used more water, and the increase in yield might have been greater than is here shown

Taking cognizance of this condition, the last Oregon legislature appropriated $7,500, to be matched by some federal bureau or state subdivision, for making complete surveys, plans, and estimates for a pioneer irrigation project in the Willamette Valley. The district engineer of the First Portland District, U. S. Army, in charge of the Willamette Valley surveys, saw fit to cooperate with the state in the preparation of such surveys, plans, and estimates. The Canby area, situated 20 miles south of Portland and embracing some 5,000 acres of fine land, was selected as the pioneer project, and surveys there are now under way.

Other surveys and studies are also being conducted by the district engineer covering the matter of flood control for the Willamette Valley, and including regulation of floods by flood-water storage, levees, and channel improvement, and also the utilization of such stored waters for improving navigation, developing electrical energy, and irrigating suitable agricultural lands. The studies thus far made indicate that there are about 1,250,000 acres of agricultural land situated in the Willamette and tributary valleys that can be irrigated; also that of the 660,000 acres on the floor of this valley, 640,000 could be served by gravity supplies and 20,000 by pumping. The remaining 600,000 acres of irrigable land lie in the tributary valleys and on the benches and rolling areas. While many of these sections could be served by gravity, some could be served better by pumping systems. All the gravity systems and some of the pumping systems would depend for their water supply upon stored flood waters. In some pumping systems, the water for irrigation might be secured from wells and other groundwater sources, and to this end limited studies are being conducted.

IRRIGATED LAND, PRODUCING 14 TONS OF STRING BEANS PER ACRE

In Fig. 2 are shown the principal irrigable areas on the floor of the Willamette Valley that may be served by gravity, also three pumping areas, all of which would secure their principal water supply from flood storage with the exception of a part of the Molalla area. The sites of some forty possible flood-control reservoirs are indicated on the map.

The graphs in Fig. 3 show by months (*a*) the composite average precipitation of five states in the northern plains area, and (*b*) the average rainfall at Albany, Ore., in the center of the Willamette Valley. This comparison shows that the upper graph is almost the complement of the lower. In the plains area, the largest amount of precipitation occurs in the summer, or crop-growing months; while in the Willamette Valley this is a period of drought. It is also a period free from heavy rains, and during our 56 years of weather records, no bank-full flood has ever occurred between the first of May and the last of October.

Because of the unusual climatic conditions, the easy storage of flood runoff will not only provide for the flood control of our streams, but will also make possible the incidental use of such storage for power generation, navigation, and irrigation, and if floods are controlled by tributary storage in Oregon and Washington, it will assure an abundance of water for large irrigable areas. When the construction costs of these reservoirs are allocated over these various prime and incidental benefits, a relatively low storage cost per acre of land would be found for the more practicable irrigation projects.

THE CASE FOR IRRIGATION

In conclusion, the advantages of irrigation in Western Oregon and Washington are many. Where, as in the larger valleys, conditions are suitable, and ample water for irrigation can be secured at the farm at a cost not exceeding $1.50 per acre-ft, irrigation is economically justified. Under certain conditions and for certain high-priced crops, even the cost of $3.00 per acre-ft for irrigating water would be warranted. Some of the foremost advantages of irrigation in western Oregon and Washington are:

1. Prevention of crop loss due to drought during June, July, August, and often in September.
2. An increase in crop yield in general amounting to over 50 per cent.
3. The growing of numerous additional crops, the successful raising of which depends upon irrigation, as Ladino clover (the best pasture grass known), beans for cannery use, and other crops requiring much moisture during the fruiting period.
4. Making available for pasture and other use certain clayey soils which during drought periods dry hard and crack; also the use of gravelly soil having an open subsoil, which without constant moisture is non-productive, and
5. The changing of the large grain-raising holdings into smaller diversified farms, thus creating a larger and more prosperous farm population and better community life.

I desire to acknowledge the receipt of helpful information which I have used in this paper, from C. I. Grimm and H. A. Rands, both Members Am. Soc. C.E., and, respectively, head engineer and senior engineer, U. S. Engineer Department, Portland, Ore.; Charles E. Stricklin, state engineer and secretary of the Oregon Reclamation Commission; W. L. Powers, soil scientist in charge, Oregon State Agricultural College; Lars Langloe, special assistant to the supervisor of hydraulics, State of Washington; L. J. Smith, agricultural engineer in charge, State College of Washington; and Harry L. Garver, investigator, State College of Washington.

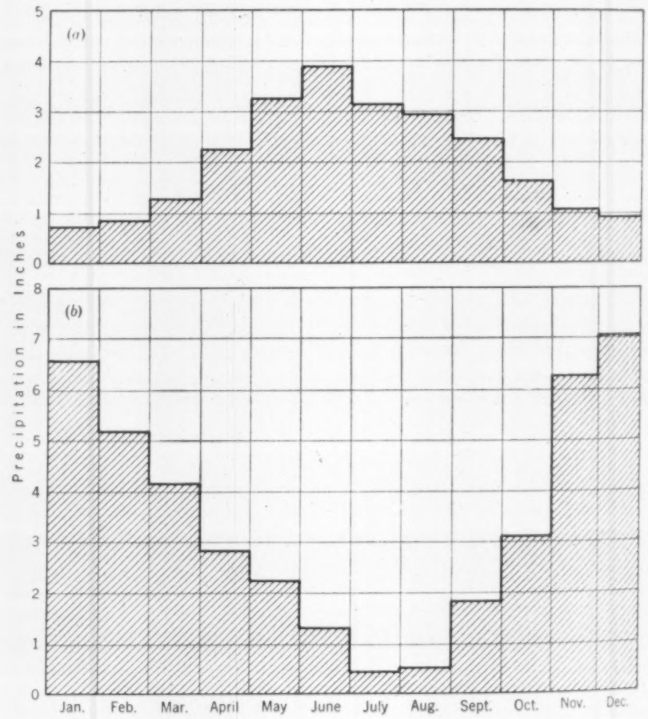

FIG. 3. MONTHLY PRECIPITATION IN IOWA, NEBRASKA, MINNESOTA, NORTH DAKOTA, AND SOUTH DAKOTA IS THE COMPLEMENT OF THAT AT ALBANY, ORE.

(*a*) Mean Precipitation for 54 Years in Northern Plains States

(*b*) Mean Precipitation for 56 Years at Albany, Ore.

The Bonneville Project Progresses

Cofferdam Cribs of Unusual Size an Outstanding Feature; Models Guide Design and Construction

BONNEVILLE Dam is a part of the comprehensive program for developing the Columbia River. Its initial electrical installation will provide 86,000 kw of prime power, and the pool it creates will establish a 30-ft channel for navigation extending 44 miles upstream. Design and construction have involved a number of unusual problems. It is no routine job to build a cofferdam where water 60 ft deep is moving at a speed of 7 miles per hour. The navigation lock has the highest lift of any in the world; the fishways—a $4,000,000 item—are of unprecedented size. The two articles in this symposium are abstracts of papers presented on July 16, 1936, at a combined session of the Construction, Power, and Waterways Divisions at the Annual Convention in Portland. In the first, Mr. Grimm describes the project briefly and reviews construction progress to date. He tells how the timber cribs of the cofferdam, high as a six-story building and tailored to fit the bed of the river, were built and placed; and how the concrete for the permanent structures is brought to the forms. In the second article, Mr. Stevens reviews the meticulous work in the hydraulic laboratory that has guided the design and construction of cofferdams, spillway, and gates, and points out that the models have saved many times their cost and have appreciably advanced the construction schedule.

Construction Methods at Bonneville

By C. I. Grimm

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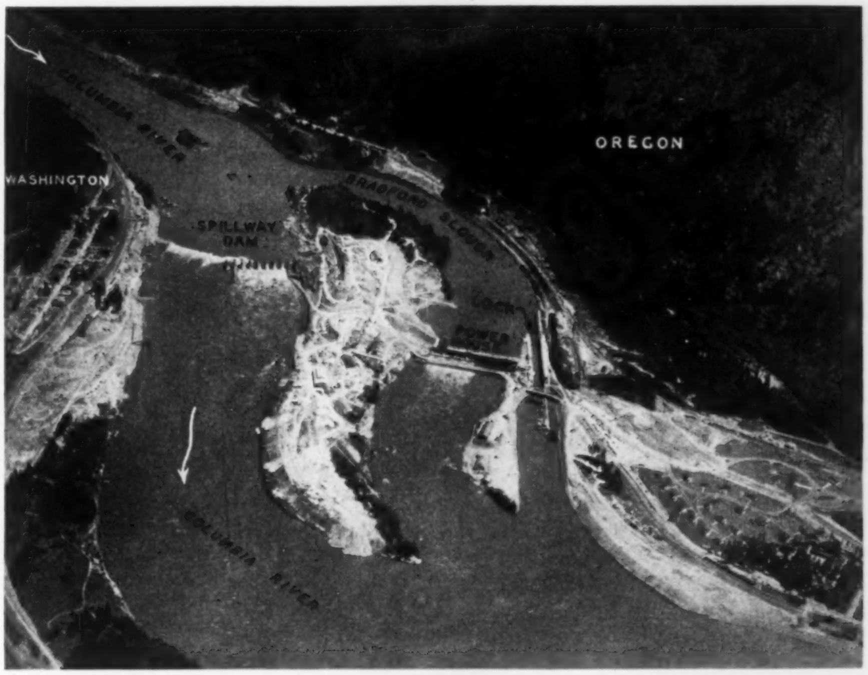
THE main structures of the Bonneville project consist of a gate-controlled spillway dam 1,080 ft long between abutments; a ship lock 76 ft wide by 500 ft long; a power house structure 608 ft long; four large fish ladders and three pairs of fish locks or lifts. The lock and power house are located in a secondary channel and founded on basalt rock at elevations well suited to economical construction; the spillway dam, on the other hand, is founded on a comparatively weak rock occurring at a depth from 40 to 60 ft below low water.

Built of reinforced concrete, the power house has a base width of 207 ft and a height of 180 ft. The initial structure will house two main units, and includes a skeleton structure for four more. The greater part of the lock chamber was excavated in basalt, which was then faced with concrete securely anchored to the rock by steel rods grouted into jackhammer drill holes. However, the upstream end of the structure consists of high walls carried up a maximum of 170 ft from deep bedrock.

The spillway dam comprises a mass-concrete sill approximately 200 ft wide and 60 to 80 ft high, set well into bedrock and supporting reinforced concrete piers that rise to a height of 72 ft above its crest. Between the piers, which support a heavy bridge and two 350-ton cranes, there are 18 steel gates, twelve of them 50 ft high and six of them 60 ft high. A reinforced concrete apron 80 ft in width and 6 ft in thickness is laid on the rock along the toe of the dam for protection against scour.



Bonneville Dam from the Air During the Summer Flood of 1936

This View Was Taken Looking East. North of the Partially Completed Spillway Structure, the Line of White Water Marks the Upstream "Second-Stage" Cofferdam

When funds were first made available for the project, in September 1933, immediate relief of unemployment was a very important consideration. However, since the foundation investigations had not progressed sufficiently to determine the final location and design of structures, the work that could be done promptly was limited to foundation exploration and construction of camp facilities, office buildings, and roads. In order to expedite employment, a contract for the excavation and construction of cofferdams for the lock and power house was awarded five months in advance of the contract for the structures, and contracts for other units of the work were awarded as rapidly as plans could be developed. The work was thus divided into numerous contracts ranging in size from under $10,000 to a maximum of about $15,000,000 for the spillway dam contract, which was awarded nine months after the first construction funds were allotted. The plan was quite satisfactory from the standpoint of providing early employment and expediting completion of the project, but it complicated the problems of engineering and management.

CONSTRUCTION OF BONNEVILLE DAM MADE NECESSARY THE RELOCATION OF 8.5 MILES OF RAILROAD

The Tanner Creek Viaduct, One of the Major Structures in This Work

Excellent transportation facilities were available. There are a railroad and a state highway on each side of the river, and the channel is suitable for barge navigation.

As labor supply and housing facilities in the immediate vicinity of the work were very limited, it was necessary to provide quarters at the site for 1,700 men during the periods of maximum employment, which reached 3,300 men in January 1935 and 3,500 men in February 1936.

Small bunkhouses having a capacity of 12 men each have been constructed to accommodate about 900 men. About 750 more can be accommodated in four large bunkhouses of the dormitory type. The contractors have constructed thirty houses for their employees, and the federal government has constructed twenty houses, a recreation building, and a permanent administration building in addition to a number of temporary buildings. In the layout of camp facilities, both the government and the contractors have given considerable attention to landscaping and architecture.

METHODS USED IN EXCAVATION

Excavation for the main structures includes 2,000,000 cu yd of rock and 4,000,000 cu yd of other material quite variable in composition. The greater part of the excavated material is utilized in roads, cofferdams, and levees, in raising and leveling low ground to be used for permanent buildings and switchyards, and in making backfills and riprapping slopes subject to scour.

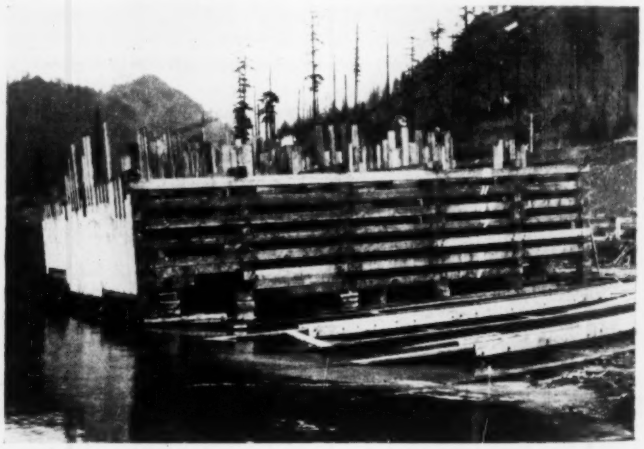
Such disposal of excavated material required the use of a flexible transporting plant, and as roads could be built readily and economically, trucks were used for conveyance. Much of the excavation above river level or within cofferdams was done with power shovels, both Diesel and electric. Subaqueous excavation was done both by dragline and dredge. An electric walking dragline with a 9-cu yd bucket has been very effective in removing material from the bed and banks, where many large boulders were encountered. From soundings the natural river bed was found to be very irregular, owing to the presence of large boulders and pinnacles, and it was decided to smooth this bottom to some extent where crib-type cofferdams were to be placed. For this work a steam-driven dipper dredge with a 5-cu yd bucket, capable of digging at a depth of 50 ft in swift water, was used, the material being loaded in dump scows. Other excavated material was hauled to disposal areas in dump trucks of various capacities up to 12 cu yd, and in buggies of sizes up to 35 cu yd.

A particularly difficult problem in excavation was encountered at the upstream end of the lock, where the rock foundation dipped abruptly to about 90 ft below low water and where the proximity of the railroad would not permit the natural slopes of an open cut to this depth. To protect the railroad tracks against undermining from slides, a concrete retaining wall 55 ft high was carried to rock within braced cells of steel piling. Excavation in front of the wall was then done in open cut to bedrock. On the other sides of the cut, it was necessary to install a well-point system and desaturate the material to prevent its flowing into the hole.

The secondary channel was easily diverted, as it carried no flow at low water. The cofferdams were built of earth taken from useful excavation in other parts of the site. In several places where leakage through the river bed under the dams or through pervious banks at their ends was of consequence, flow was greatly reduced or entirely stopped by dumping fine sand and silt into the water where the leakage entered.

UNPRECEDENTED PROBLEMS IN COFFERDAMMING

In the main river channel the flow is deep and swift. The ordinary low-water discharge is 75,000 cu ft per sec, and summer floods of 700,000 cu ft per sec are to be expected. The stage fluctuates about 30 ft between ordinary high and low water. Obviously the work of unwatering this channel involved unprecedented problems and risks that few contractors could assume. The specifications consequently provided that the federal government would design the cofferdams, which are of the timber crib type, pay for them on a quantity basis, and assume responsibility for loss from external water pressure, flood, or ice, after each crib was placed and accepted. The contractor is responsible for each crib until it is satisfactorily placed and loaded.



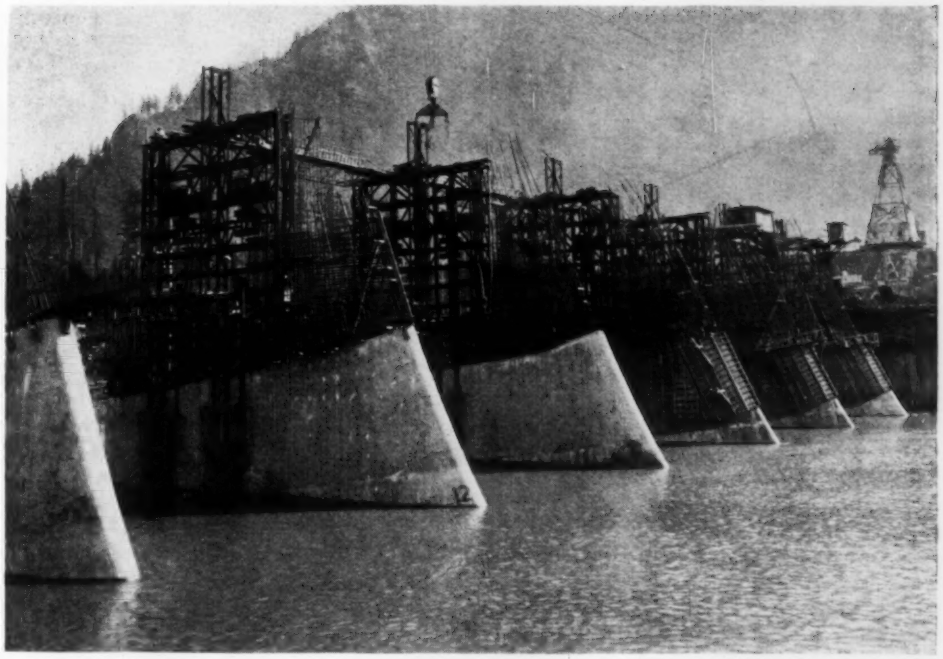
THE LOWER PART OF A COFFERDAM CRIB, READY FOR LAUNCHING

The Irregularly Shaped Bottom Is Designed to Conform to the Bed of the River

Pictures of models in the second article of this symposium indicate the stages in this unwatering program. The first-stage, or south cofferdam was constructed in four months in the winter of 1934–1935, in water having a maximum depth of 50 ft and a velocity of 7 miles per hr.

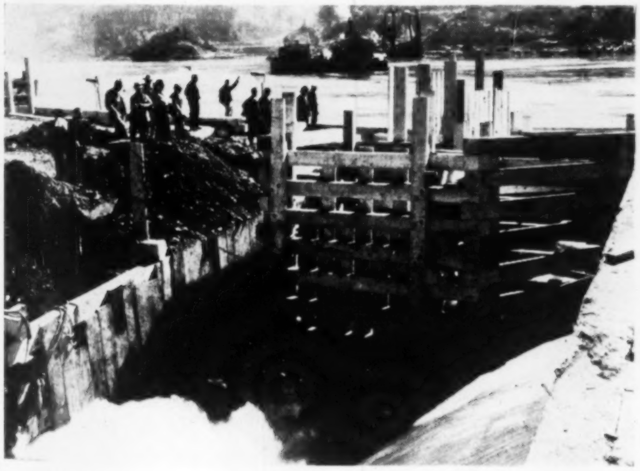
The cribs, some of which had to withstand a 60-ft head of water, were generally 60 ft square in plan. They were constructed of 10 by 12-in. and 12 by 12-in. Douglas fir timbers, crossed to form cells 12 by 12 ft in plan and securely bolted together. An unusual feature of their design was that the bottoms were shaped to fit roughly the irregularities of the dredged river bed on which they were to be seated.

Each crib was built up to a height of about 15 ft on sloping ways located on the bank. It was then launched and moved to its final position, where additional courses were added until the height exceeded the depth of the river by a few feet. Suitable material was then dumped into the weight pockets—usually from trucks—to sink it. When it touched bottom, soundings were made and divers were sent down inside unfilled cells to check the fit of the crib to the river bottom. It was necessary in a few cases to blast out boulders that prevented proper seating, and in one case some timbers were blown out to permit the crib to settle. In general, the cribs of this dam landed within a foot of their theoretical horizontal position, with tops fairly level and within a foot of their theoretical elevation. A diaphragm of interlocking steel piling was driven at the outside of the crib structure to prevent leakage.



Partially Completed Piers of the Spillway Dam
At the Extreme Right the Traveling Tower of the Construction Cableway Can Be Seen

For constructing the cribs of the second-stage, or north cofferdam, floating launching ways of a new and improved type were installed. These ways are lowered by cables and sheaves, supported by piling, as the crib is built up, and at the proper time a further lowering launches it. While placing the last cribs of the upstream arm of this dam, in a depth of over 60 ft of very swift water, a pull of 1,200,000 lb was measured on the upstream holding lines.



Closing the Upstream Arm of the North Cofferdam
The Wedge-Shaped Crib Is Being Guided Into Position by Lines from the Barges, Which Are Anchored to the Pinnacle Upstream. Water at This Point Is 60 Ft Deep

To remove the south cofferdam, cribs Nos. 1 to 6 and 15 to 20 were blasted by numerous charges inserted into 3-in. steel pipes built into the corners of the 12-ft cells for that purpose. The timbers were sufficiently shattered by this method to be removed by the dipper dredge and the dragline along with the fill material.

MIXING AND DISTRIBUTION OF CONCRETE

Two complete concrete plants have been set up, one on Bradford Island by the General-Shea Construction Company, contractor for the lock and power house, and the second on the Washington side of the main channel by the Columbia Construction Company, contractors for the dam. Both plants are of the modern automatic batching type. The first has two 3-cu yd mixers with a total capacity of 3,000 cu yd in 24 hours, and the second has four 4-cu yd mixers with a total capacity of 6,000 cu yd in 24 hours. Both of the sites for main structures are spanned by double cableways with a fixed tower at the north end and two traveling towers at the south end. The cableways over the main channel have a span of 2,020 ft and a travel of 850 ft, and those across the power house channel have a span of 1,450 ft with 600 ft of travel.

As far as it is practicable to do so, concrete is delivered by cableway bucket directly to its place in the structures. Concrete pumping plants are provided to distribute it to work out of reach of the cableways or inaccessible to cableway buckets because of the nature of forms and reinforcing. Although the specifications did not require the use of vibrators, the contractors elected to use them to facilitate placing.

Mass concrete in the dam was placed in 5-ft layers on a slope of one in eight, dipping upstream. Specifications required that these pours be uncovered for 72 hours for cooling. To further control the generation of heat and the resulting formation of cracks, a special cement was specified. This cement, known as Portland-puzzolan, contains 25 per cent of interground calcined puzzolanic material. In mass concrete 0.9 to 0.95 bbl per cu yd has been used and the rise in temperature, where the concrete is placed in 5-ft layers, has been about 35 F. The con-

THE COFFERDAM CRIBS WERE SHATTERED BY BLASTING TO FACILITATE THEIR REMOVAL
There Were Two Tons of Explosive in This Charge

crete placed to date has been relatively free from cracks.

Foundations of the dam and the power house were grouted beneath concrete-filled trenches located along the upstream side. At the power house the grouting was done from the bottom of the trench before concreting. Holes were drilled on a longitudinal line 10 ft apart, alternate holes 20 ft apart being grouted first. The dam foundation is being grouted from a longitudinal tunnel directly over the cut-off trench. As the rock under the dam is uncovered, it is tested for seams by core drilling to determine the required extent of final excavation. In addition to numerous small holes, several 36-in. core-drill holes in each cofferdam are specified. This testing is considered necessary as the rock is of variable quality, and seams or strata of very weak material are likely to be encountered.

Rates of progress on all phases of the work have been carefully estimated, planned, and charted. Progress data show the work to be about 60 per cent complete as of July 15, 1936, and the date of completion, including all operating equipment, will be December 1937.

Models Cut Costs and Speed Construction

By J. C. STEVENS
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HYDRAULIC models of the Bonneville Dam have saved many times their cost and have substantially accelerated the construction schedule of the project. The experiments have been carried on in an outdoor hydraulic laboratory built especially for the purpose at Government Moorings, in Portland.

The first study undertaken was the design of apron and baffles for the main spillway dam. At the dam site, the bedrock—a tuffaceous agglomerate—is exposed for a width of a hundred feet or so in the center of the channel, and dips under river gravel and boulders toward each bank, where the overburden is 40 to 60 ft thick. This rock is not hard, and would doubtless scour under the prolonged impact of water passing over the dam. It was therefore desirable to retain the overburden of river gravels and boulders intact if possible.

For this study a 1:36 model of a 180-ft length of the main spillway was constructed. It included three of the 50 by 50-ft crest gates, two piers, and two half-piers. The river bed was simulated by a mixed gravel from $^1/_4$ to $^3/_4$ in. in mean diameter. This composite was about the equivalent of the river bed with all material less than 8 in. and over 30 in. in mean diameter removed.

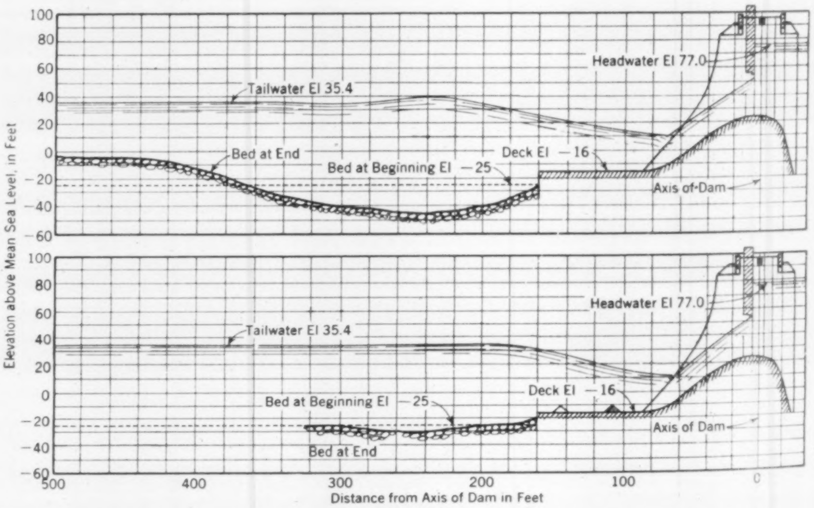


FIG. 1. SCOUR BELOW THE SPILLWAY DAM AS INDICATED BY MODEL STUDY
Top, Horizontal Deck Without Baffles; Bottom, Adopted Design

The river bed actually contains a goodly percentage of boulders greatly in excess of 30 in., but as the object of the experiments was to determine the types of baffle that would produce the least scour, exact similitude was not essential provided the bed of the model was more easily scoured than that of the river itself.

In all, 140 experiments were run on as many different combinations of deck and baffles. All tests were run under identical conditions as regards gate opening, time, forebay and tailwater levels, and discharge, and the bed was carefully leveled before each run. Hence the scour at the end of each run reflected the relative efficacy of the particular design under investigation.

The type of baffle finally adopted is novel, and as far as indicated by the experiments, the most effective for preventing scour at this structure (Fig. 1). It consists essentially of blocks staggered in two rows. Each block is 6 ft high and 6 ft wide, and both the upstream and the downstream face are on a slope of 1 on 1. The blocks in each row are placed with a clear 6-ft space between them. It was a surprise to find that the downstream sloping face of the baffle block was very effective in preventing scour, but once the fact was established a theory to account for it was discovered in the phenomena of turbulence and stray currents.

It was noted that if the apron could be raised to El. −8, the height of the hydraulic jump would correspond very closely with the normal tailwater elevation for all flows less than 800,000 cu ft per sec. This in itself would have eliminated any tendency to scour. For practical reasons, however—principally the saving in cost and the possibility that there will be a recession of the river bed below the dam after it has been in operation a number of years—the deck was lowered to El. −16.

COFFERDAM DESIGN AND INSTALLATION THOROUGHLY STUDIED BY MODELS

The task of installing cofferdams to unwater a river carrying upwards of 300,000 cu ft per sec at depths up to 80 ft was one of the outstanding construction problems of the Bonneville project, and model studies proved an indispensable aid in its solution. The three stages in the unwatering program may be described briefly as follows. First, a cofferdam was built to expose about 8 acres of the south half of the main river channel adjoining the Oregon (Bradford Island) shore. Within it the piers were completed and the overflow portion was built to El. −8.0, or 32 ft below the crest of the completed structure. In the next stage, now under way, the north half of the river bed has been exposed, and water is permitted to flow over the partially completed spillway on the Oregon side. Inside this second cofferdam the spillway and piers will be built to full height. In the final stage, the partially completed spillway will be closed off, a portion at a time, by means of a portable timber caisson and a portable bulkhead resting respectively against the upstream and downstream sides of the piers. With these structures in place, the enclosed space will be unwatered and the overflow portion between piers built to full height.

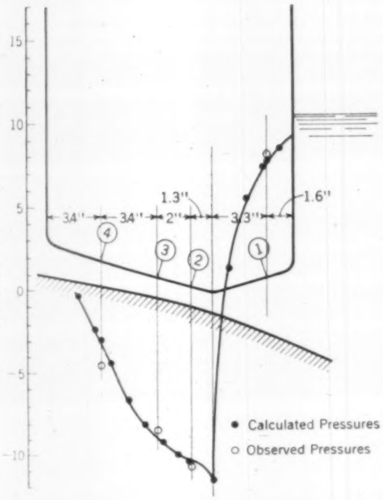
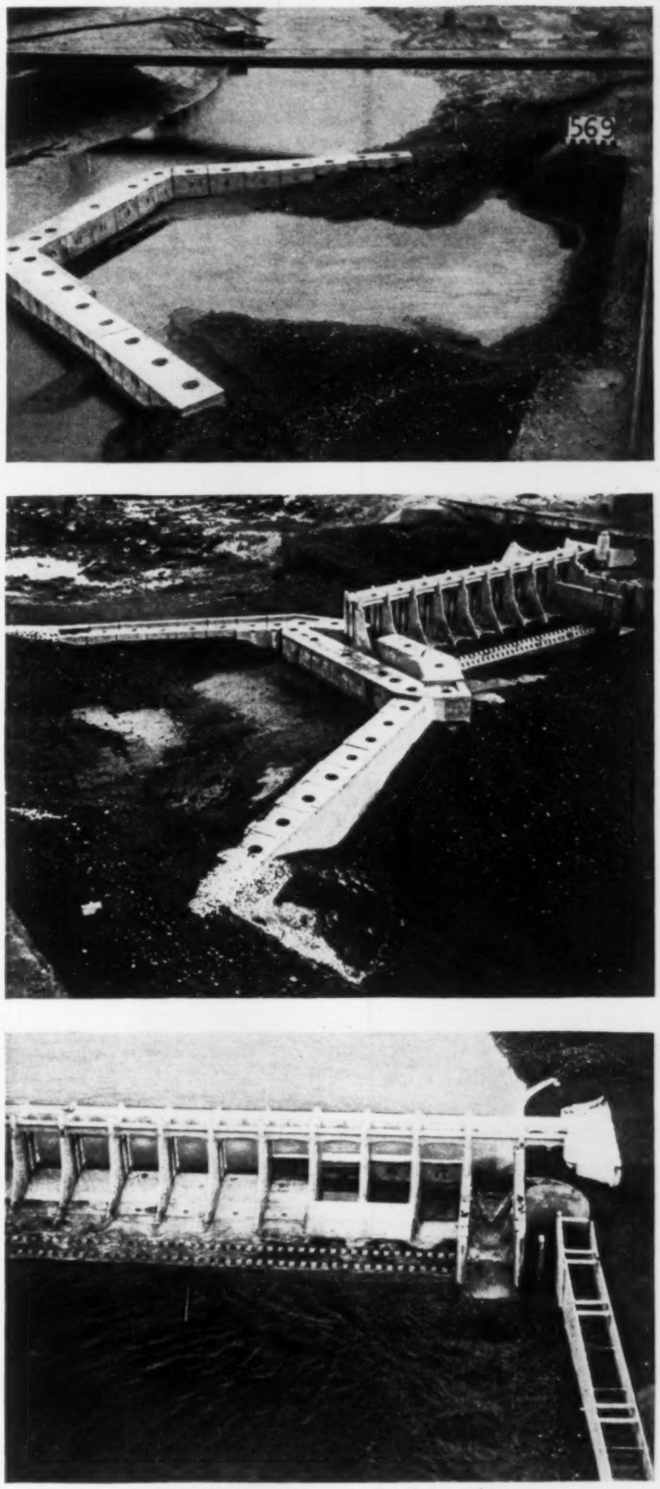


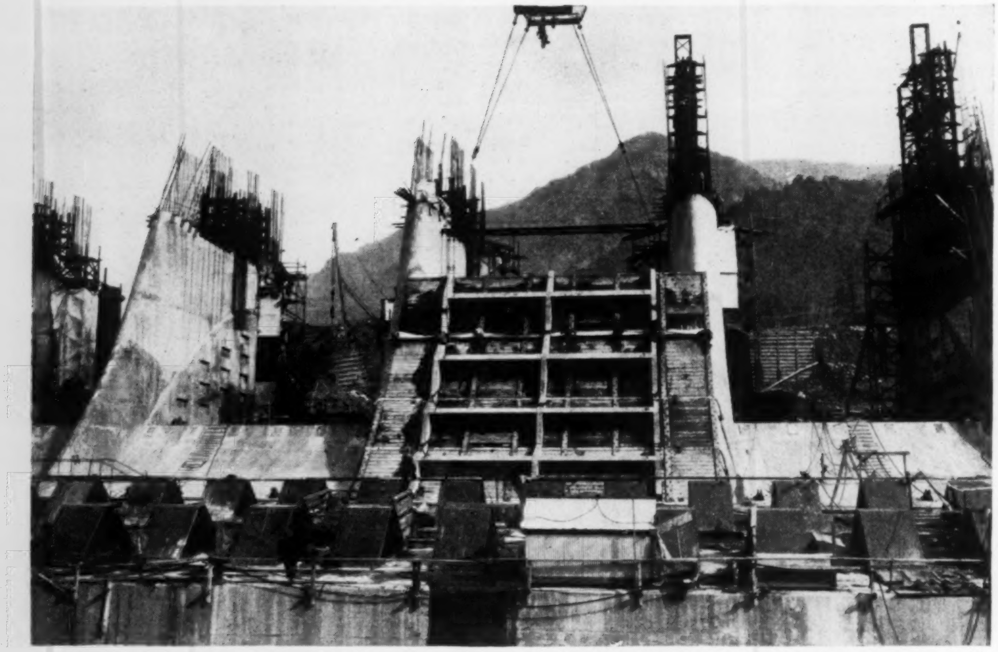
FIG. 2. TYPICAL PRESSURE DISTRIBUTION ON BOTTOM OF MODEL CREST GATE

Piezometer Locations Are Indicated by Circled Numbers



EVERY STAGE OF THE UNWATERING PROGRAM WAS SUBJECTED TO DETAILED STUDY WITH MODELS

Top View Shows the First-Stage Cofferdam. In the Middle Picture the Second-Stage Cofferdam Is in Place. At the Bottom, Two Bays of the Spillway Are Bulkheaded Off to Permit Raising the Overflow Portion to Its Final Elevation



BAFFLES ON THE MAIN SPILLWAY DAM

Bulkhead Spanning Center Bay Will Serve as Cofferdam for Third Stage of Construction

The final closure will be made at low water, when a considerable part of the discharge can be passed through the four skeleton units of the power house.

As shown in an accompanying group of illustrations, every step in the unwatering program was the subject of model studies. The prototype cofferdams were timber cribs built on ways on the shore, towed into position, and filled with material from excavation. The upper picture shows the model of the first-stage cofferdam after a test run. When the construction schedule was first planned it was thought that it would only be possible to build cribs Nos. 8 to 13 and two end cribs in each wing (Nos. 1 and 2, and 20 and 21) before the spring freshet. Model studies, however, showed that it would be possible to complete the cofferdam, carry on excavation inside until the spring freshet, and then remove the equipment and let the cribs be overtopped during the flood without damage. This plan was actually followed, thereby advancing completion by one season.

MISCELLANEOUS TESTS ON COFFERDAMS AND FISHWAYS

The connection from the last crib to the river bank is an earth fill. The size of stone for riprap required to hold the fill was determined by models. The pull on the cables for placing each crib, amounting in some cases to a million pounds, was similarly determined for the various river stages likely to be encountered, and was later verified by a tension meter to have been forecast within 10 per cent. Finally, models were used to predict the amount of sand that would be left inside the submerged cofferdam during spring floods of various magnitudes. The quantity was later verified to be 20,000 cu yd for the 1935 flood of 500,000 cu ft per sec.

In all respects the first-stage cofferdams functioned almost exactly as forecast by the model studies. As the contractor was unable to complete the second-stage cofferdam before the 1936 flood, it is not yet possible to report the comparative behaviors of model and prototype for this structure. As of October 1, 1936, the cofferdams have been placed and excavation inside them practically completed.

If we could have modeled salmon our joy would have been complete. We did determine, however, for fishways of many types the current velocities, eddies, and turbulence the salmon would have to negotiate in their migration upstream. The traps finally adopted for the main spillway consist essentially of a non-return entrance into the gate areas at each shore. Fish are enticed into the traps by currents produced by partially open gates. Once inside the trap they have a choice between a fish ladder and a fish lift, but they cannot go back downstream.

During the second stage of unwatering, the velocities between piers of the incomplete spillway are too great for salmon. One bay has therefore been studded with baffle piers to reduce velocities to permit their passage. The fishways over the draft tubes of the power house were also studied by models.

CAVITATION TESTS OF CREST GATES

Water passing at high velocities under the large crest gates of the spillway would cause cavitation and enormous vibrations unless precautions against them were taken. A 1:5 model, 2 ft in width, of the gate was constructed in a flume, the bottom of which was molded to simulate the crest of the dam. This gate was supported on platform scales so that the vertical force components could be determined by weighing.

The crest gates may be put into either of two grooves in the piers, giving them an upstream and a downstream position. Normally the gates are in the downstream position, except the two end gates controlling the fish traps, which are in the upstream grooves.

In the downstream position the water falls away from the gates as it passes under them, completely aerating the sheet. This, however, is not true for the upstream position. In Fig. 2 is shown the form of the bottom of the gate as finally adopted, the slope of the crest of the dam, and a typical pressure diagram of the water

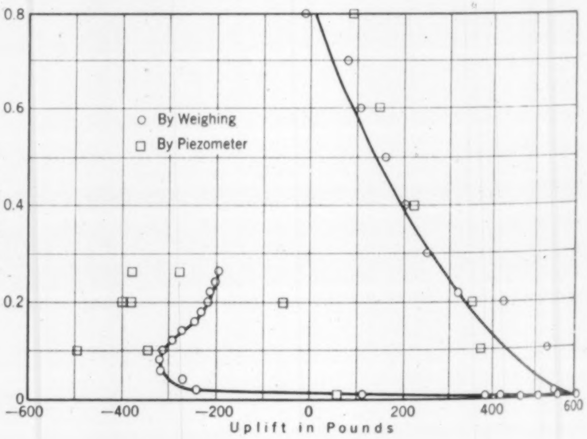


FIG. 3. UPLIFT ON MODEL GATE IN UPSTREAM POSITION

passing between the crest and the gate (upstream position).

In Fig. 3 is shown the net uplift in pounds on the model for various gate openings and sequence of openings with the gate in the upstream position. When the gate is first opened the surface of the nappe adheres to the under side of the gate until an opening of 0.26 ft is reached. Within most of this range the force of the water is downward (negative uplift). After this opening is passed the nappe breaks free and there is an actual uplift on the gate. Once the nappe is free the gate may be closed completely without the nappe again adhering to the gate, during which process the uplift increases. Note that when the gate is first opened the uplift varies widely from +600 to −240 lb as the gate is raised only 0.02 ft. Within this range a sudden jar will start the gate vibrating most violently—sufficiently, in fact, to wreck it completely if continued.

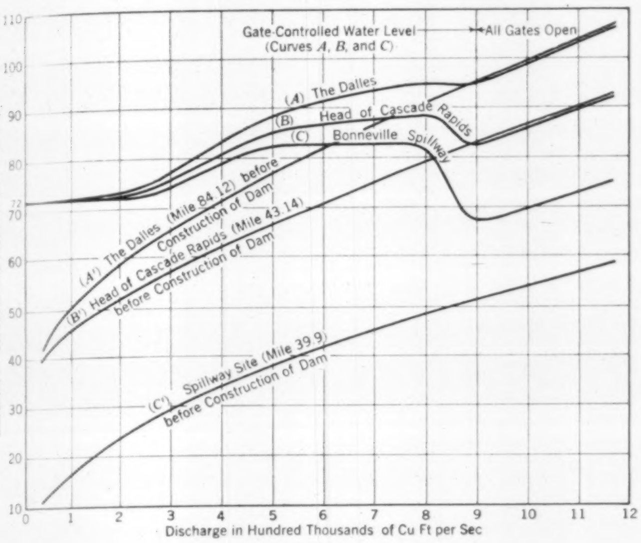


FIG. 4. COLUMBIA RIVER RATING CURVES, SHOWING CONDITIONS BEFORE AND AFTER CONSTRUCTION OF BONNEVILLE DAM

The remedy for this danger was found in thoroughly aerating the under side of the gate as near as possible to the seal. After aeration holes were put in, no vibration could be produced. Three rows of staggered holes, equivalent to a one-inch open slot the full length of the gate just downstream of the seal, were incorporated in the design of the prototype as a result of these tests. Since the behavior of the vacuum in the prototype is not reproduced to scale in the model, results of these tests are given in terms of the model only.

BACKWATER EFFECTS AND CHANNEL IMPROVEMENTS

From the dam to the head of Cascade Rapids the river channel is very rough and the water very turbulent. Imagine water flowing 15 ft deep among boulders the size of automobiles and summer cottages. What is the coefficient of roughness? It obviously has no meaning. If, however, the depth be increased to 60 ft, a roughness factor can be found.

In order to determine surface curves by models, it is exceedingly important that the roughness of the model simulate that of the prototype. This similitude can be established by trial only. River profiles for known flows were previously observed. An approximate profile during the flood of July 6, 1894 (1,170,000 cu ft per sec) was also available. The model was built to the grades and elevations obtained by river cross-sections. Then water was turned into it and the channel was roughened until the flow profiles simulated those observed in nature.

The computation of the backwater curves that will obtain after the dam is in operation was attended with some uncertainty because of the great roughness and turbulence. It was gratifying to find, therefore, that the backwater curves in the model demonstrated the overall accuracy of the computations.

Perhaps the most important result secured by the model studies, and one that could hardly have been found in any other manner, was that of outlining certain channel improvements between the dam and the head of Cascade Rapids to compensate for the effect of raising the water level by the dam.

By the removal of some 225,000 cu yd of material above low water at restricted sections of the channel, flood heights after the dam is completed will be no greater above the rapids than they were before (Fig. 4). It is important to note that the rating curve for the dam site after construction, curve *C*, is about 16 ft higher than that before construction, curve *C'*, for flood flows above 900,000 cu ft per sec. Although the water level is thus raised at the dam, flood heights at the head of Cascade Rapids, curves *B* and *B'*, and at The Dalles, curves *A* and *A'*, are slightly less than before construction.

These backwater effects are of great significance in reducing costs of flowage rights and flood damages. They were made possible by the channel improvements previously mentioned, and could not have been determined in any other manner so well as by hydraulic models.

CURRENTS THAT MIGRATING SALMON MUST NEGOTIATE WERE CAREFULLY INVESTIGATED

This Elaborate Fishway Is One of Four Provided to Safeguard an Important Industry

Stream Cleansing in Oregon

Esthetic Considerations Are the Major Factor in Determining the Extent of the Program

In thickly populated districts, stringent control of river pollution may be necessary to safeguard the public health. In other localities, where the danger is not so acute, but where municipal water supplies are drawn from polluted streams, it may be possible at least to justify a comprehensive control program on economic grounds. But in Oregon, pollution does not reach the point of endangering health, and most of the cities take their water supplies from pure sources. True, in certain streams some measures must be taken to protect the salmon industry, but in general the dollars-and-cents value of pollution control in this state is subordinate to the esthetic value. Oregon's rivers are playgrounds, and Oregonians are interested in preserving them as such. In the first of the following articles, Mr. Koon traces the history of pollution control in the state. He suggests that much legislation on the subject is too drastically prohibitory, and that better enforcement will result from laws fashioned to yield elastically to practical necessities. Next, Mr. Green outlines the status of municipal sewage treatment in the state, and describes briefly a number of recent installations. In the concluding article, Mr. Merryfield points out the problems caused by dumping liquid industrial wastes into the streams, and tells what can be done to solve them. The three articles are abstracts of papers presented before the Sanitary Engineering Division on July 16, 1936, at the Portland Convention.

Past and Present Efforts to Reduce Pollution

By R. E. Koon

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If all the urban population of Oregon were assembled in one city, such a city would rank twelfth among the great cities of the United States, being comparable in size to Milwaukee or Buffalo. Of this population 71 per cent is in the Willamette River valley, an area less than 12 per cent of the total area of the state. In the entire state, probably about 530,000 persons should reasonably be served by adequate sewage treatment facilities. If they were assembled in a single city as advantageously situated as Portland, such facilities could probably be secured for three or four million dollars, and operated for perhaps 25 cents per capita per year. Distributed as it is, this population can be adequately served only after a capital expenditure of perhaps six or eight million dollars and provision for an operating charge of 50 to 65 cents per capita per year.

To carry this general picture a little further—no city water supply in the state is taken from a stream which is now grossly polluted or is ever likely to become so. When this year's construction program is completed only one city will be taking water from a stream that is subject to even moderate contamination, and this city, by the end of next year, will have abandoned that supply and secured a better, from a source which will never be seriously contaminated. Throughout the state, except in the high, sparsely settled eastern and central portions and in the vicinity of a very few towns elsewhere, an abundance of splendid water is available at moderate cost.

The foregoing statements seem essential to a fair evaluation of the efforts towards stream purification in this state. They make it quite evident that great expenditure for the abatement of stream pollution is not justified from the standpoint of protecting municipal water supplies and only in a minor sense for protecting rural supplies. Why then is there so great a public demand that pollution of streams shall cease?

OREGON IS A STATE OF NATURE LOVERS

Oregon, to a great extent, is peopled by those who came here to live because it was a state whose virgin resources were relatively unimpaired. These people had an instinctive love for undefiled nature and a desire to live in close contact with it. Through the years they have seen the hand of man deface or destroy great areas of natural beauty; have watched the ever-spreading road system penetrate the wilderness; and have gradually become conscious that the streams that formerly gave pleasure to the eye and provided recreational and sporting facilities in abundance have become great sewers, in some places so foul that the joy of seeing and using them has gone. The more practical-minded have also noted the serious effect of pollution on the life and propagation of commercially valuable food fish.

To the depletion of forest growth the nature-lovers are resigned, for such destruction has seemed necessary to secure a livelihood for a large part of the population. Roads into the public domain have been encouraged in the general interest. But to the pollution of streams, this part of Oregon's population will never be reconciled. It rightly feels that such destruction of a natural resource is wholly unnecessary and has developed as a result of public tolerance of conditions brought about by the selfishness of communities and industry.

To summarize the motives which have served in the past and will serve in the future to hasten or retard stream purification in Oregon, two main ideas mark the rallying points; those opposed say "It costs too much," and those in favor say, "It is folly to permit unnecessary destruction of a natural resource of great value to the state."

MANY ANTI-POLLUTION LAWS ARE TOO DRASTIC

In 1903 the law was passed which created the State Board of Health and prescribed its functions. This has been amended from time to time. Recently John Ronchetto, attorney-at-law, acting in behalf of the Stream Purification Committee of the State Planning Board, has made an exhaustive study of all federal and state laws of the nation relating to stream pollution. The results of this study have been made permanently useful in the form of extensive memoranda and legal analyses. As a preface to his report Mr. Ronchetto has this to say:

"A consideration of the legal aspects of stream pollution precipitates a study of the chaotic character of legislative attempts to control a vexatious problem of ever-increasing importance. The welter of conflicting statutes and doctrines of the common law aggravates the perplexity of the problem by failure to accept the irrefutable tenet that ultimate purification cannot be attained overnight through legislative or judicial fiat. Major considerations of a practical and highly technical nature are inappropriately approached by legislative assemblies and courts, and, in the final analysis, the rigid application of legal rules must be fashioned to yield elastically to practical necessities of the situation in hand."

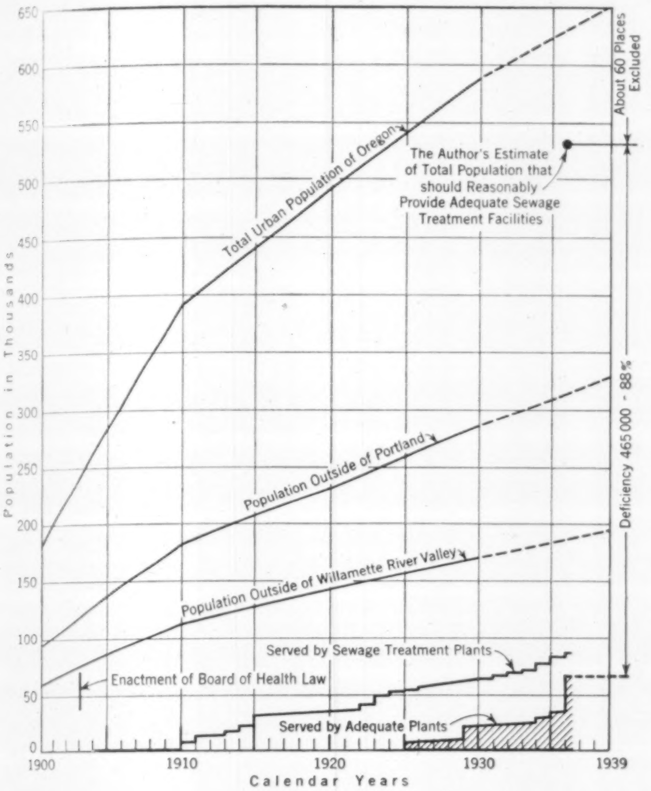

Fig. 1. URBAN POPULATION OF OREGON, SHOWING PORTION SERVED BY SEWAGE TREATMENT FACILITIES

Oregon has enough law to make and keep her intrastate streams as pure as they were when Lewis and Clark camped on their banks, but mere law does about as much to prevent stream pollution and correct admittedly evil conditions as it does to prevent the sale of intoxicating liquor and eliminate drunkards. Oregon, like many other states, has too much law that is drastically prohibitory in its form and consequently goes unenforced because it cannot marshall enough public opinion to support it. The special committee of the State Planning Board just referred to has undertaken, as its major activity, the drafting of a law relative to stream pollution which will be "fashioned to yield elastically to the practical necessities of the situation in hand." If this can be accomplished, the resulting document will be placed before the 1937 session of the state legislature and recommended as an amendment to existing laws. If this program is successful, it is expected that the cause of stream purification will be greatly benefited.

SEWAGE TREATMENT PLANTS IN OREGON

We have made a rather painstaking attempt to trace the development of works for the treatment of sewage in Oregon during the past thirty years. The results are indicated by Fig. 1. In so far as inquiry has shown, the honor of making the first attempt at sewage treatment goes to the city of Wasco in north central Oregon. In 1904, with a population of a little over 300, this little town built a sewer system and a septic tank which are still in use. Subsequent to that date other septic tanks were built to serve various cities. In 1913 the first two-story (Imhoff) tank was built at Bend. There followed other plants of one type or the other, and in 1925 La Grande built the first "adequate" treatment plant, replacing one which was obsolete. This plant, of the trickling filter type, was built only after much litigation and after the city had paid considerable damages for discharging inadequately treated sewage into irrigation ditches. In 1929, Klamath Falls built a modern primary treatment plant including a mechanically cleaned sedimentation basin, separate sludge digestion tanks, and gas utilization equipment. A mechanical "detritor" was added in 1933.

At present there are about 40 sewage treatment plants in the state. Of these only 13 can be classed as "adequate." Eleven of the latter group have been built in the past three years with the help of government funds.

MANY GROUPS HAVE STUDIED STREAM POLLUTION

In 1919 the present state law in reference to stream pollution was passed. But as pointed out earlier, its provisions are so drastic that extensive public support for its enforcement has not been obtained. In 1926, certain organizations interested in outdoor life and alive to the recreational advantages of the state, demanded that city, county, and state officials enforce the law. A general study and report on conditions in the Willamette River valley, which outlined recommendations for a sanitary study of the river at low water, was made by H. B. Hommon, sanitary engineer, U. S. Public Health Service. During this year also, the Oregon Anti-Stream Pollution Committee was named, consisting of representatives of the State Board of Health, Fish Commission, and Game Commission, the City Engineers of Willamette River Valley, and a number of sportsmen's organizations. This committee recommended a state-wide sanitary survey of streams, which the legislature considered in January 1927 but failed to approve.

A report on "Control of Stream Pollution in Oregon" by Rogers and Langton of Oregon State College was published in March 1929. During the same month a State Stream Pollution Committee was formed at a conference at the University of Oregon, and definite study assignments were given to various official and semi-public organizations.

In June 1930 the results of a sanitary survey of the Willamette River by H. S. Rogers and C. A. Mockmore, Members Am. Soc. C.E., and C. D. Adams, all of Oregon State College, were published in bulletin form (Bulletin Series No. 2, Engineering Experiment Station, Oregon State College).

Early in 1933 the Anti-Stream Pollution Council was organized and was active and successful in promoting an election to vote an issue of $6,000,000 in bonds for sewage treatment works to serve the city of Portland. For a number of reasons the funds have not yet been provided for construction purposes. The bonds voted are of the utility type, payable only from revenue to be derived from service charges. In November 1934 a proposal to make them a general obligation of the city was defeated at an election.

Just prior to this election the city had a further sanitary study made of the condition of water in Portland harbor. The tests showed that there was no dissolved oxygen in a three-mile stretch of river, during periods of low water.

In May 1933 a conference of city authorities in Portland resulted in the appointment of a board of consulting engineers to serve under the then existing State Reconstruction Advisory Board and to make a general study of sanitary conditions in the Willamette River valley. The report, by Robert G. Dieck, John W. Cunningham, and R. E. Koon, all Members Am. Soc. C.E., was published under date of August 26, 1933. About the same time a technical committee financed largely by private appropriations of paper companies, made a study and report, as yet unpublished, on the effect of sulfite pulp and paper wastes on Willamette River water. This report is now in process of publication as a bulletin of the Engineering Experiment Station, Oregon State College.

PRESENT STATUS OF THE PROGRAM

The Water Resources Division of the Advisory Research Council, acting in an advisory capacity to the State Planning Board, in October 1935 created a special division known as the Stream Purification Committee. This committee, composed of 15 members, is active and is the only body now known to be making definite efforts towards a reasonable and effective program of stream purification. The committee is composed of engineers, bacteriologists, representatives of several branches of industry, and city officials and others who represent the public. The committee holds frequent meetings and has definite functions, which it is sincerely attempting to perform. The main goal it has now set for itself is the preparation of a suitable stream purification and protection law for the consideration of the 1937 legislature.

These are the high lights of past and present efforts towards stream purification in Oregon. The future of sewage treatment and stream pollution abatement will depend upon public opinion as to the relative social and economic value of dollars in hand and decency. The state is making definite progress towards the ultimate elimination of the greater part of the pollution load on streams. A very strong public sentiment is supporting these efforts, and it can be expected that before the difficulties have reached hopeless proportions, a sane and feasible program of stream pollution abatement will be adopted and made permanently effective.

Present Status of Municipal Sewage Treatment

By CARL E. GREEN

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STATE SANITARY ENGINEER, PORTLAND, ORE.

THERE are 192 incorporated cities and towns in Oregon, of which 177 have public water systems either municipally or privately owned, 81 have sewer systems, and 30 have sewage treatment plants. In addition to the incorporated areas, there are 6 other communities and 7 large public institutions which have treatment plants.

Efficient sewage treatment plants have been constructed in Oregon only within recent years. The large number of streams throughout the state and the rather sparse population have led to the general practice, in the larger cities, of disposal by dilution. In some cases, however, where the combined load of municipal sewage and industrial waste is a maximum during the low-flow period, complete treatment plants are required, although during the greater part of the year primary treatment may be adequate to maintain reasonably satisfactory stream conditions.

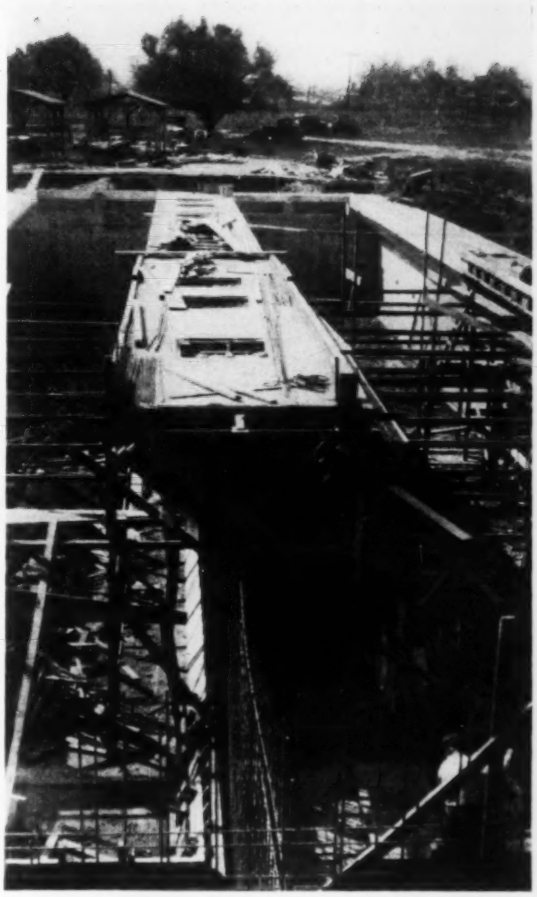
ACTIVATED SLUDGE PLANT AT MEDFORD, ORE., COMPLETED IN JULY 1936
Blower House in Right Background; Sludge Pumping Station, Laboratory, and Digester at Left

In the Willamette Valley, where the bulk of the state's urban population is to be found, several sewage treatment projects are now under consideration. Moreover, should the comprehensive program of flood control now being prepared by the U. S. Army Engineers be carried to completion, the low-water flow of the Willamette River would be increased sufficiently to materially improve conditions.

At this time ten cities, two government reservations, and one large county institution have complete treatment plants in operation or under construction. Most of the old plants are septic tanks which were constructed to serve small communities located in most instances along minor water courses. But septic tanks today are obsolete for the treatment of city sewage, except possibly in a very few cases.

Court decisions have led to the construction of some of the better plants. Many cities, however, have undertaken projects of their own volition. For several years, cities of the Rogue River valley have been working successfully toward the elimination of sewage pollution of that river and its tributaries. Four cities in this area—Ashland, Grants Pass, Medford, and Talent—have constructed modern treatment plants during the past year. Their cooperation in this worthy enterprise is to be commended. The economic, esthetic, and recreational values restored by these new plants will be demonstrated within a short time.

In Oregon the trend is, and should continue to be, toward the elimination of unreasonable stream pollution, although in this state the accepted standard of what constitutes unreasonable pollution is perhaps different from that accepted in many densely populated and highly industrialized areas. The people of Oregon realize that recreational resources constitute one of the state's major assets, and that the construction and efficient operation of sewage treatment plants will result not only in the protection of water supplies and aquatic life, but in the preservation of recreational values as well.



Aeration Units Under Construction at the Medford Sewage Disposal Plant

METHODS OF FINANCING CONSTRUCTION

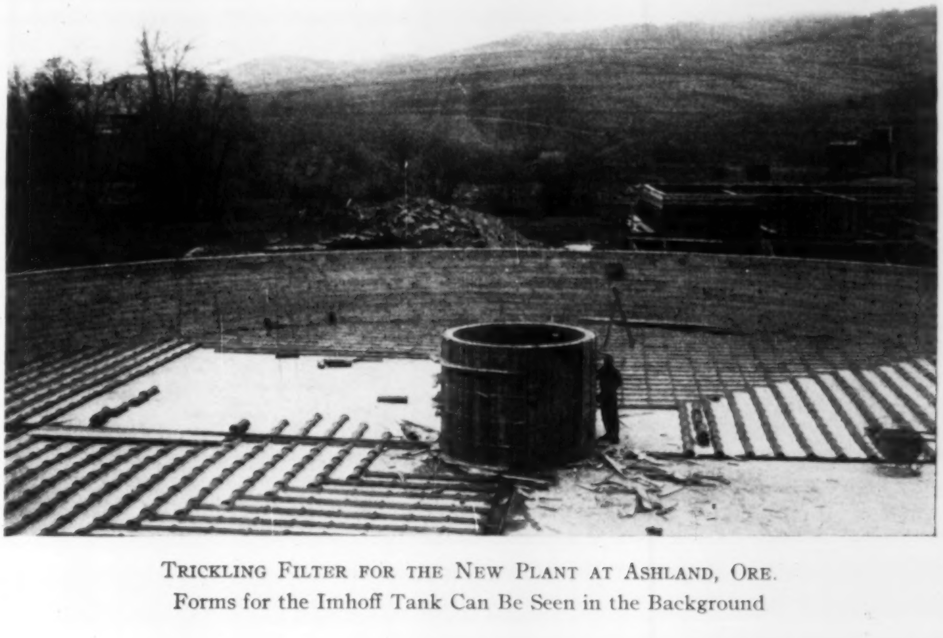
The recent impetus for the construction of sewage treatment works can be attributed in a large measure to the federal public works and work relief programs. All plants constructed during the past two years have been constructed with federal funds, at least in part. However, for some of these projects adequate study and design have been impossible because of haste in getting the work under way.

Various methods for financing the construction and operation of sewage treatment plants are available to Oregon cities. Improvement bond assessments, sewer rental or service charges, general tax levies, or a combination of these different methods may be used. Local charters may limit the methods of financing in certain cities. Sewer rental or service charges seem at this time to be the most popular. Charges may be based on flat rates, the amount of water used, the kind of building and plumbing fixtures that are installed, or other methods. An equitable way to finance a complete sewerage system and treatment plant in a municipality is to pay for the sewers by assessments, and for the construction, operation, and maintenance of the treatment plant by rental or service charges.

All the plants so far constructed in Oregon have utilized biological processes. In spite of a revived interest in chemical precipitation in recent years, no plants utilizing this process have been built in the state, nor are any planned at this time.

Prior to 1936, no activated sludge plants had been constructed in the Pacific Northwest. Three plants of this type, however, will soon be in operation in Oregon—at Medford, Burns, and Hillsboro.

The general country-wide trend in the use of rotary distributors for trickling filters is well illustrated in this state. Rotary distributors are provided in the new plants at Ashland, Baker, Gresham, Lakeview, Warm Springs, and Multnomah county farm. As elsewhere, these units are being used because they operate under lower heads, distribute the settled sewage more evenly over the trickling filter bed, and result in a cheaper filter installation.



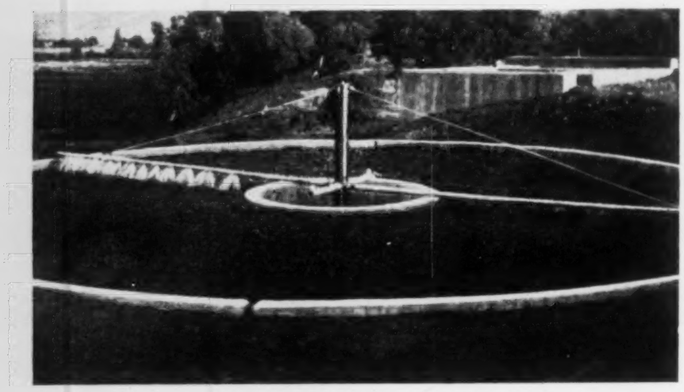
Trickling Filter for the New Plant at Ashland, Ore.
Forms for the Imhoff Tank Can Be Seen in the Background

For primary sedimentation, mechanically cleaned clarifiers have been preferred by engineers in this region except under unusual conditions. Both circular and rectangular sedimentation units have been used. Two Imhoff tanks have been constructed in 1936 at Ashland and Talent, where favorable sites allowed the use of Imhoff tanks and trickling filters without pumping equipment.

Separate sludge digestion equipment, with provision for gas collection and utilization, predominates in the newer plants, but to date no units for the generation of electric power from sludge gas have been installed. Gas is being used for heating sludge and incinerating screenings.

An interesting modification of an Imhoff tank was made this year (1936) at Pendleton. The sludge storage capacity of the tank being inadequate, a separate sludge digester was added to provide the required storage. A pump transfers sludge from the lower story of the Imhoff tank to the digester, which is equipped with a stirring device. Gas will be used for heating sludge.

Another novel plant serving 650 people at the Multnomah county farm is worthy of mention. It consists of a hopper-bottomed sedimentation tank, separate sludge digester, trickling filter equipped with a rotary distributor, hopper-bottomed final settling tank, and chlorinator. To obviate the necessity for electric power, the plant was designed to operate entirely by gravity. Sludge is transferred from the primary tank by drawing supernatant liquid from the digester to the final settling tank. This withdrawal takes place because of the difference in head between the primary tank and the digester. Sludge is returned from the final settling tank to the primary tank by means of an injector. Water to operate this device is supplied at a pressure of about 85 lb per sq in. through a pipe line extending from the institution buildings. Although the latter are located at a much higher elevation than the treatment plant, and back-siphonage to them could not occur, a vacuum breaker is installed on this water line as a factor of safety. The only electric current used in the plant is for heating the chlorinator house during the winter months.



SEWAGE TREATMENT FOR A TOWN OF 400 POPULATION
The Plant at Talent, Ore., Completed in August 1936, Includes Imhoff Tank, Trickling Filter, and Chlorinator

To date no Oregon city has thought it advisable to manufacture commercial fertilizer from sewage sludge. All the modern plants in the state are now dewatering digested sludge on drying beds. Two plants have glass-covered beds. No sludge, either raw or digested, is being incinerated.

INSTALLATION AND OPERATING COSTS

For modern primary treatment plants, the average installation cost was $6.64 per capita for four cities, ranging in population from 520 to 16,100. Two plants in this group received no aid from the federal government. For complete treatment plants—that is, those which produce stable effluents—the average net construction cost was $11.90 per capita for 11 cities, ranging in population from 210 to 11,010. In this group, 7 were built with PWA assistance, and 3 with work relief assistance. These figures do not include the cost of intercepting or outfall sewers, nor do they include federal grants.

In comparable plants, operating costs vary more than installation costs. In some cities all sewage must be pumped, whereas in others no pumping is needed. Again, some chlorinate the effluent and others do not. At this time actual operating costs are known for only a few plants. To obtain the following average figures, costs at the others have been estimated. The average for primary plants without pumping is $0.22 per capita per year. For Klamath Falls, the only city with a primary plant which must pump all its sewage, it is $0.32 per capita per year. For complete treatment plants where pumping is not required, the average operating cost is $0.55 per capita per year. For those cities with complete treatment in which pumping is required, the average cost is $0.60 per capita per year.

Industrial Wastes in the Willamette Valley

By FRED MERRYFIELD
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ASSISTANT PROFESSOR OF CIVIL ENGINEERING, OREGON STATE COLLEGE, CORVALLIS, ORE.

THE major part of Oregon's industry is in the Willamette Valley, and the Willamette is the most seriously polluted river in the state. Like most of the other streams west of the Cascades, it is primarily rain fed. During June, July, August, and part of September, the rainfall amounts to not more than 2 in., and is distributed in light showers. The flow of the river decreases slowly during this period, reaching a minimum of 4,000 cu ft per sec at Salem in September or October.

This low flow coincides with the period of maximum industrial pollution. Pulp and paper mills, lumber mills, creameries, woolen mills, tanneries, and many other small industries contribute their load during the whole year, but canneries and the state flax retting plant start work in the latter part of May or early in June, and the maximum load is reached in August and later, when the soft fruits and vegetables are in season.

TABLE I. DATA ON WILLAMETTE VALLEY PULP AND PAPER MILLS

Item	Mill Number				
	1	2	3	4	5
Distance from Portland, river miles	91	68	33	9	9
Max. plant capacity, tons of paper per day	26	110	..	370	220
Average output, tons of paper per day	24	100	..	350	135
Sulfite plant capacity, tons pulp per day	30	110	..	84	80

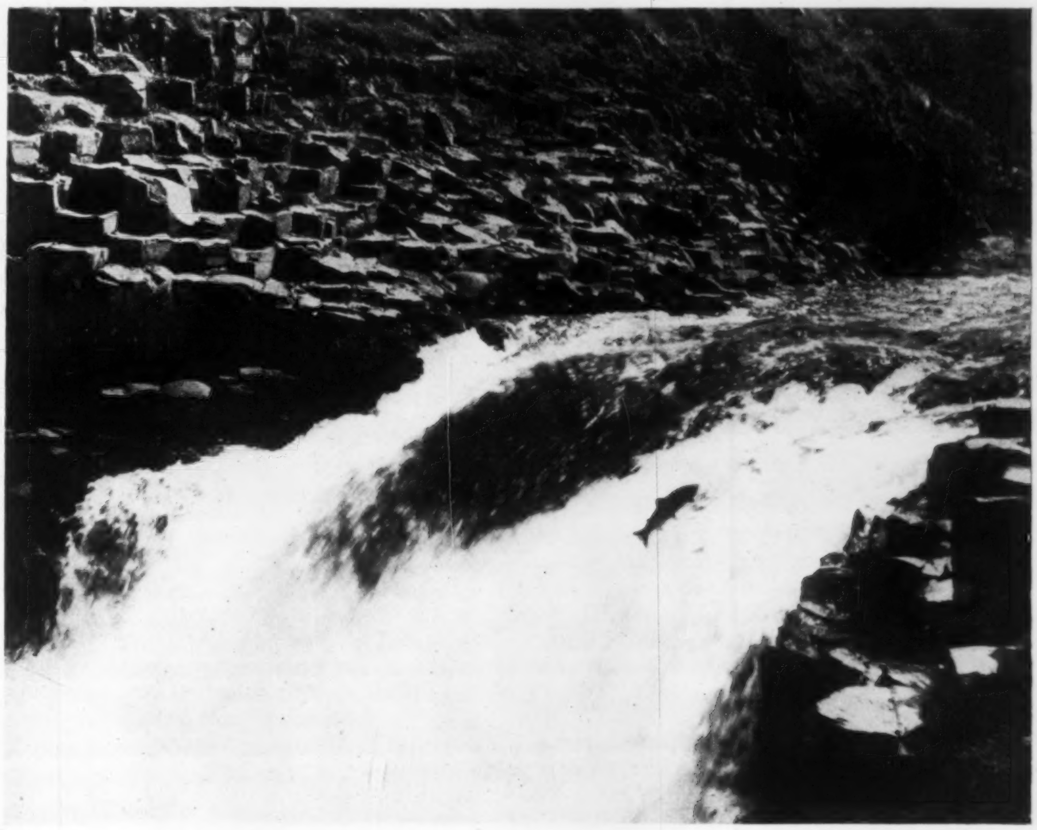
At this time the oxygen content of the river is seriously depleted before it reaches Portland. Above Salem the river is practically saturated with oxygen—except in one of the upper forks where serious domestic pollution occurs—but from Salem, the 68 river miles to Portland become progressively worse, and it is hazardous to use the water in the river in the lower stretches.

The Willamette is little used as a source of water supply but is valuable to the state as a recreational area. Its headwaters, moreover, are a valuable spawning ground for salmon and for many of the game fish. Commercial fishing is a large industry at the mouth of the Columbia, with a yearly revenue of between six and ten million dollars; the pack of salmon is about a half million cases yearly in the best seasons. As one of the major lower tributaries of the Columbia, the Willamette is one of the main sources of this industry. Game fishing in the rivers of Oregon provides considerable trade within the state and gives excellent sport as well.

INDUSTRIES IN THE VALLEY

There are five pulp and paper mills in the valley (Table I), one on a tributary and four on the main stream. Approximately 2,000 gal of sulfite liquor are produced per ton of pulp. The amounts of white water, sulfite mill waste, and spent bleach liquor vary widely with the method of plant operation and are dependent on the amount of water used and on the efficiency of the plants. In all but one of the plants the wastes are discharged immediately or finally into the stream with no treatment except for fiber recovery.

Several thousand acres around Salem are seeded to flax every year, and about 3,000 tons of flax straw are produced. The entire crop to date has been purchased by the state and is processed in its retting and scutching plant in Salem. The flax is placed in bundles in concrete tanks and the tanks are filled with water at 70 to 90 F. The dissolved oxygen in the water is rapidly used up and anaerobic decomposition takes place in the pectose which binds the fibers. Some of the water is removed daily, and warm, fresh water is added until the retting is completed in five to ten days. The retting water flows directly to the river untreated. It is estimated that 5,300 gal of retting wastes are discharged per ton of flax straw treated. Approximately 15,900,000 gal are dumped into the river each season. Three or four plants are either being built or are proposed for construction in this area.


© Frank I. Jones

A SALMON CLEARS THE PUNCH-BOWL FALLS WITH A 12-FT LEAP

Woolen mills and tanneries also discharge their effluent into the river. Many sawmills operate in the valley and on the coast. Practically every town has its own creamery, and there are several condenseries and ice cream and cottage cheese plants scattered over the state. No attempt has been made to treat their wastes, and very little if anything is known of their volume. Waste from gas manufacture has been adequately treated at the plant in Portland with the result that little if any finds its way into the river.

Briefly this gives some idea of the load that the rivers, particularly the Willamette, must carry at the most unfavorable time of the year. The quantities of wastes discharged of course represent only one side of the picture. It is important that their strengths be known. Fortunately, through the cooperation of the pulp and paper industry with various state agencies and the Oregon Engineering Experiment Station, both the quality and quantity of the wastes from this industry were investigated in the summer of 1933. The pulp and paper industry produces a fairly even product throughout the year, so it was possible to make an estimate of the pollutional load as determined by the bio-chemical oxygen demand.

Numerous samples of the flax retting wastes have been taken at various times in the last six years, and good estimates have been made from volumetric calculations of the quantity of material discharged. Their accuracy depends largely on the method of operation. Many samples have been taken of cannery wastes, but it has not been possible to make any reliable estimates or measurements of quantities.

The strength of the various wastes is given in Table II in terms of oxygen demand. Wnile the bio-chemical oxygen demand does not necessarily represent all the pollutional factors, it is significant for comparative purposes when obtained by standard testing methods. The effect of such wastes on fish life requires more study than has yet been given to it. Their effect on breeding grounds and on the aquatic flora and fauna itself has not been fully determined. The B.O.D. of the industrial wastes was in great part due to the dissolved solids.

TABLE II. STRENGTH OF INDUSTRIAL WASTES, IN PARTS PER MILLION OF PLANT EFFLUENT

INDUSTRY	WASTE	B. O. D.		SOLIDS			pH
		5-day	20-day	Total	Susp.	Diss.	
Cannery	pear	590	1,630	4,040	200	3,840	6.40
	pumpkin	210	515	667	129	538	4.41
	carrots	1,630	2,900	5,270	2,520	2,730	5.0
Tannery	tannery	1,780	2,960	21,640	1,310	20,330	10.4
Packing	meat packing	1,300	22,500	2,360	780	1,580	6.56
	dissolved	1,000	1,400	....	...	....	...
Woolen	wool scouring	13,000	21,800	51,000	...	....	9.0
	wool finishing	1,420	3,850	13,560	...	....	9.1
Flax	retting	2,700	5,300	4,200	...	4,200	4.8
Paper mill	sulfite lqr.	8,760	16,400	90,400	150	90,250	5.45
	bleach lqr.	20	62	574	52	522	6.47
	white water	28	71	242	134	108	5.57

The flax and sulfite liquors contained practically no suspended solids. Many soft fruit wastes contained a considerable portion of suspended solids but the demand for oxygen was still relatively high for the dissolved solids. The grinding of some of the offals into the waste discharge increased the dissolved solids and increased the demand about 350 per cent. Pears, being a large part

GOOD ROADS HAVE MADE THE NATURAL BEAUTIES OF OREGON ACCESSIBLE TO UNTOLD THOUSANDS

of the Oregon pack, must place a fairly large burden on the stream. The potency of wool-scouring wastes is well known.

TREATMENTS TRIED OR SUGGESTED

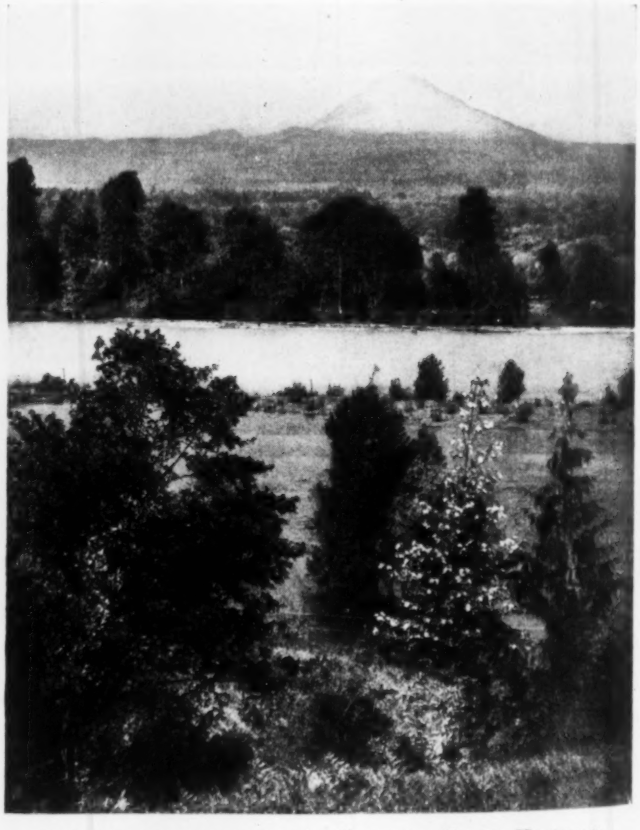
In the pulp and paper plants in Oregon, "save-alls," in use for many years, have reduced the loss of fiber to a minimum. The flax waste can be reduced, according to preliminary experiments conducted by the Engineering Experiment Station, from 130 lb of oxygen per ton of flax straw to 75 lb, by precipitating the retting liquor with 0.5 per cent lime. This amounts to 222 lb of lime per ton of flax retted. Chemical precipitation with lime, or lime and some flocculating agent, followed by biological filtration, would result in a highly stabilized effluent.

Cannery wastes vary greatly and are dependent on plant operation as well as on the crop canned. In several plants the waste is screened, and the offal is hauled away and spread on the ground, although this method of disposal adds considerably to the cost. Grinding the peelings and dumping them into sewers has been tried at one plant. Fruits and vegetables with high sugar content contribute largely to stream pollution. One small town is proposing to take care of one of the larger canneries by providing a separate treatment plant. The high B.O.D. of the dissolved sugars and the large volumes and high moisture content of peelings and cores present outstanding problems.

With the probable increase in the growing and canning of vegetables, the disposal of their waste products will become a more serious problem. The possibility that some of these wastes may have an economic value should be studied by agricultural chemists and engineers. It will be necessary to operate movable pilot plants to determine by what method the B.O.D. can be reduced.

It has been shown by two sanitary surveys of the Willamette, and by numerous spot samples taken over a period of many years, that the Willamette River is greatly depleted of oxygen by the time it reaches the boundaries of Portland. This, coupled with the instability of many of the wastes and the addition of sewage from a population of more than 300,000 people, renders the river entirely unfit for most uses in the vicinity of Portland. A major part of this pollution has been shown to come from industries on the river at and below Salem, although the domestic sewage entering the river above Portland is not negligible.

While many people believe that enough studies have already been made, it is obvious that much remains to be done to remove this pollution. To require that wastes be kept out of the stream entirely might impose such burdens on certain industries that it would become uneconomical for them to operate. That the problem is unsolvable does not necessarily follow. But designing and building of plants for the removal of industrial wastes depends on knowing how to remove those wastes economically. A design may be structurally and hydraulically sound but chemically and biologically inadequate. Again, even good design is no guarantee of proper operation, a fact not well comprehended by a great many people. Pilot plant studies are necessary where information is lacking on proper methods of reduction, and full-size plants should be built only where there is no question that a known method is efficacious.



A SCENE ALONG THE LOWER COLUMBIA RIVER HIGHWAY BELOW PORTLAND, ORE.

Control of Pest Mosquitoes for Comfort

Some Practical Ways to Limit Breeding of Non-Disease-Bearing Species

By Harold F. Gray
Member American Society of Civil Engineers
Engineer, Alameda County Mosquito Abatement District, Berkeley, Calif.

While much has been said and written about the control of the malaria and the yellow-fever mosquito, the tendency in the past has been to tolerate rather than to take steps toward the control of non-disease-bearing, or pest, species. Yet it is possible today to insure a high degree of physical comfort against such mosquitoes throughout the temperate zones, to maintain satisfactorily comfortable conditions in tropical areas, and even to provide reasonable security against attack in certain parts of the subarctic regions. The cost in most cases is very moderate. In the following article, abstracted from his address of July 16, 1936, before the Sanitary Engineering Division at the Society's Portland Convention, Mr. Gray makes a number of very practical suggestions looking toward abatement of such nuisances in this country. Some mosquito breeding is the result of conditions over which man has no control, but human carelessness appears responsible for a large part of the trouble in populated areas.

Few people are aware of the amount of discomfort caused by pest (as distinguished from disease-bearing) mosquitoes throughout the world, or of the economic loss and frustration resulting from their prevalence. This discomfort is encountered not only in the "great open spaces," but also under strictly urban conditions; it occurs not only under tropical and semitropical conditions, but throughout the temperate zone, and in aggravated form in the subarctic regions. It is doubtful if any city, town, or village is without a pest-mosquito problem in some degree. The nuisance may vary from a widespread invasion of salt-marsh mosquitoes, to intense infestations of a fresh-water domestic species localized in small areas. A few typical cases will serve to outline the problem.

Some years ago the late Noble M. Stover, one of the first and ablest of the "mosquito men" on the Pacific Coast, stopped at a fine new hotel in the state of Washington one day in summer. That night he was assailed by great numbers of mosquitoes, all of the common domestic species, *Culex pipiens*. After fighting them a large part of the night, he checked out of the hotel the next morning. Later Mr. Stover persuaded the manager to make an inspection with him. It was found that several ornamental ponds of a miniature golf course next door were producing hundreds of thousands of mosquitoes each night. The application of two gallons of kerosene stopped the trouble at a total cost of forty cents. As the mosquitoes moved out, guests moved in.

On a downtown corner of Oakland, Calif., is located a large unit of a national chain-store system. A few years ago mosquitoes began to annoy the office force, and soon became so numerous that even the customers were bothered. When customers began to leave the store without buying, the management reported the trouble to the mosquito abatement district. Within a few hours the cause was found in a partially blocked basement drain, and when this was cleaned out the nuisance promptly ceased.

Oiling a Catch-Basin, by Motorcycle with Pressure-Spray Equipment

CITIES PROVIDE BREEDING PLACES

Instances such as these are constantly occurring in the densely built-up commercial and industrial sections of every city. In the aggregate, the output of pest mosquitoes in cities is far larger than people unacquainted with the facts would suspect.

The causes of urban mosquito nuisances group themselves into several general types: Defective maintenance of buildings or structures, defective engineering or architectural construction, general human carelessness, and invasion by migrating species.

Building drains and plumbing facilities that are broken or out-of-order produce some of the most intense and annoying nuisances, but their effect is usually localized and they are not met with frequently. The detection of the source may be exceedingly difficult, and weeks or even months of search have sometimes been required before the breeding place was found.

Defective engineering construction occurs chiefly in catch-basins or street inlets to sewers, underground street-vaults of public utilities, and railroad and highway culverts. The street inlet or catch-basin is frequently a prolific source of mosquitoes. A modern type of inlet on a storm sewer seldom gives trouble, but the old catch-basin type, particularly on combined sewers, is a prime nuisance (Fig. 1, *a*). Sufficient water remains in the bottom of the catch-basin throughout the year to furnish an excellent breeding place. In a city of half a million population there may be 10,000 or more catch-basins, each a potential breeding place.

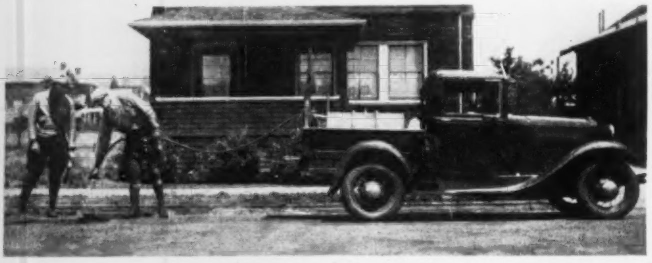
The old catch-basin should be eliminated as rapidly as possible, and new inlets of a non-mosquito-breeding type, as shown in Fig. 1 (*b*), should be installed. In this type, the bottom is shaped so as to prevent the accumulation of water, conducting it all to the lateral drain. If there must be a trap on the line to prevent odors, which may be necessary on combined sewers, the trap should be at the manhole, not at the inlet.

APPLYING LARVICIDE BY MOTORCYCLE

For the control of mosquito breeding in catch-basins and utility street-vaults, pending reconstruction, we have found that a three-wheeled motorcycle fitted with pressure tank and accessories is the most efficient means of applying either oil or larvicide. Such a rig, designed under my direction, has been in use in Alameda

County for the past year with excellent results. With it one man inspects an average of 250 catch-basins per day, of which 170 require oiling. The cost, including depreciation, is approximately 3 cents per catch-basin inspected and/or oiled.

In the principal commercial areas of cities, the wires of the power and light, telephone, and telegraph utilities run underground. The pipes of the gas and water utilities are also carried throughout the community in underground conduits. Both have, as necessary accessories, underground vaults for access to the wires and pipes. In a city of half a million population there may be four or five thousand such vaults. Many may be drainable into adjacent storm sewers, but in our experience, about one-half are not so drainable and are extraordinarily prolific mosquito breeders. Nothing can be done to permanently correct the trouble if the sewers are not deep enough to drain the vaults, and as a result we have to use either an oil or a larvicide.



CREW OILING TELEPHONE VAULT WITH OIL UNDER PRESSURE

Utilities object to the use of heavy oils, for such oils make the splicing of electric cables difficult. The use of volatile kerosenes or distillates may, under some conditions, produce an explosive mixture of air and volatile hydrocarbons. Petroleum distillates having a specific gravity of 28 to 30 are relatively safe, and have practically none of the objectionable tarry or asphaltic fractions to gum up the cables.

Use of intermediate petroleum fractions, however, requires several oilings per season to prevent mosquito breeding. Our preference, therefore, is for a non-volatile larvicide, the best for the purpose being an emulsified cresylic acid. The most toxic fraction of crude cresylic acid is that which distills between 225 C and 250 C. This fraction, emulsified with about 10 per cent soap (dry basis by weight), gives a larvicide which is effective in dilutions as low as 1:40,000, over a period of six months or more. It should be applied to produce a 1:20,000 dilution with the water in the vault. In this dilution, it cannot have any appreciable corrosive effect upon concrete or metals.

RULES FOR PLACING CULVERTS

Far more consideration must be given to the placing of railroad and highway culverts if mosquito breeding in pools or swampy places above or below the culverts is not to occur. The railroad or highway engineer is entirely satisfied if his culverts pass the maximum probable flood flow without endangering the embankment, and is not worried if a puddle or a small marsh results above or below the embankment. But from the standpoint of public health and comfort, this is a matter of great concern. The following simple rules for culvert placement, which increase the cost of construction little or not at all, are offered for the purpose of mosquito prevention: Take enough topography or levels on each side of the roadway so that the natural slope of the ground is clearly indicated, and also the low point; place the culvert at the low point; make the grade of the invert of the culvert correspond with the natural ground slope; leave no holes or depressions above or below the culvert, and make a smooth, straight channel to and from each end.

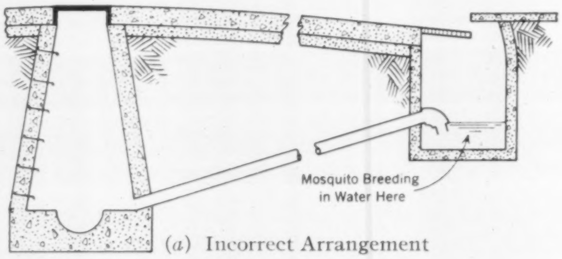
Proper placement of culverts is absurdly simple, and it has long been a mystery to me how so many highway and railroad engineers could contrive to put them in wrong so frequently. Engineers and contractors are also at times extremely careless in permitting stoppages of waterways during the construction of projects, which may result in considerable public discomfort. A little forethought would prevent such nuisances.

Architects come in for their share of the responsibility for this public nuisance. One of their favorite contributions to the prevalence of mosquitoes is the undrained elevator pit, which is capable of producing enough mosquitoes to keep a whole city block slapping. Of course, a little oil can be put on the pit waters to destroy the mosquito larvae, but why present the insects with favorable breeding places?

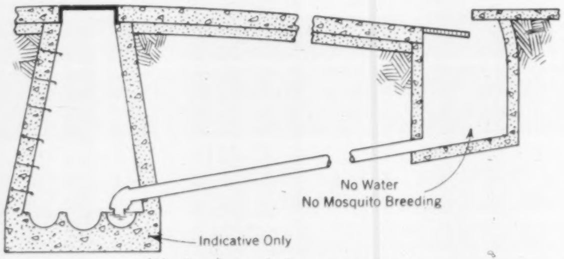
Another architectural sin is placing a house or other building practically on the ground, with little clearance under the first-floor joists. If a drain breaks or is clogged, or the occupant runs a refrigerator drain through the floor, there is a fine mosquito breeding pool under the house which is hard to get at, either to inspect, to oil, or to drain. Some architectural "ornamentation" also may provide breeding places for mosquitoes. Such things as urns, for example, unless provided with a drain hole at the bottom, will collect rainwater and produce astonishing numbers.

Spaces between buildings also make excellent mosquito-breeding grounds. When a steel-frame building with concrete exterior walls, or a reinforced-concrete building, is built adjacent to an existing building which is flush with its property line, a space is necessarily left for forms. Not only does this leave an area difficult to get at, in which mosquitoes can breed freely, but as the form lumber is seldom removed, a first-class focus of termite infestation is also produced. Architects should require that all such form lumber be removed, and that the space be roofed over to exclude rain water.

But aside from defective design, construction, and maintenance, human carelessness is responsible for a large amount of local mosquito breeding. It has been my observation that the average man can carelessly create new mosquito-breeding



(a) Incorrect Arrangement



(b) Preferred Arrangement

FIG. 1. STREET INLET DESIGN HAS AN IMPORTANT BEARING ON URBAN MOSQUITO CONTROL

places faster than the usual abatement force can find and eliminate them. Buckets, barrels, tin cans, cesspools, and other water containers are frequent sources of mosquitoes, as is also the ornamental garden pool not stocked with fish.

One of the by-products of the depression has been a particularly pernicious practice indulged in by some people who apparently cannot afford to pay for rubbish removal, although they can afford to operate automobiles. These people sack their tin cans, haul them to the outskirts of cities, and dump them along the less built-up streets and roads. When filled with rain water, these cans produce mosquitoes. In Alameda County we attribute the great increase in breeding of *Theobaldia incidens* in the hill areas in the past three years to this source.

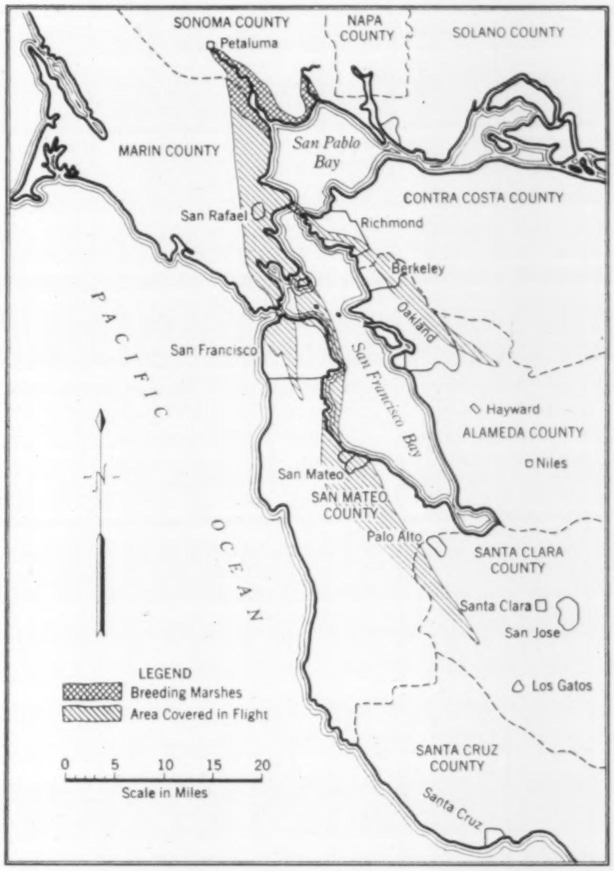


FIG. 2. ANNUAL SPRING MIGRATION OF *Aedes Squamiger* MOSQUITO IN THE SAN FRANCISCO AREA

MIGRATORY RANGES OF SOME COMMON SPECIES

Pest mosquitoes causing local nuisances in American cities are principally members of the *Culex* genus, for example, *Culex pipiens*. But there is a widespread group of temperate-zone and subarctic species, the *Aedes* genus, which causes probably the greatest annoyance and economic loss of the non-disease-vector species. These *Aedes* species are usually strong flyers and migrate in vast swarms far from their breeding places. Along the coasts, they are usually salt-marsh breeders, while inland they are generally bred in overflow areas left after spring floods have subsided. In the high mountains they breed in pools left by melting snow, and in subarctic regions they appear in enormous swarms shortly after the snow melts.

People along the Atlantic Coast have long been familiar with the "Jersey" mosquito, and its reputation as a formidable biter has been widespread. It extends also along the Gulf Coast to Texas. Prior to the inauguration of abatement measures against these salt-marsh species (*Aedes sollicitans* and *Aedes cantator* on the Atlantic Coast; *Aedes sollicitans* on the Gulf; and *Aedes squamiger, Aedes dorsalis,* and *Aedes taeniorrhyncus* on the Pacific Coast), economic loss and human and animal discomfort were enormous. Their successful abatement has made both industry and agriculture more productive, and life in the regions formerly infested has been made comfortable.

A statement frequently heard is that mosquitoes do not travel more than a mile, and usually a much shorter distance, from their breeding places. While this is substantially correct for the common domestic species, there are several species in the *Aedes* genus which migrate considerable distances in large swarms. On the Atlantic Coast the "Jersey" mosquito, *Aedes sollicitans,* migrates 10 to 20 miles from its breeding ground. Out on the Pacific Coast there are well-authenticated migrations of more than 40 miles.

For example, the annual spring migration of *Aedes squamiger* in California on numerous occasions has been observed and followed from the breeding grounds along Petaluma Creek in Sonoma and Marin counties. Hatching out about March 10–15 and migrating a few days later, the swarm of from 10 to 20 billion insects usually proceeds south. In Fig. 2 the extent of these migrations is indicated. About 10 miles to the south, a part of the swarm breaks off from the main body and goes southeast, jumping a mile-wide water gap, into Contra Costa County, and thence into Alameda County, a total flight distance of about 30 miles. The main body proceeds south, splitting into two groups.

The group going down the Sausalito peninsula jumps the Golden Gate (a little over a mile wide) at about the location of the new Golden Gate Bridge, and then spreads out over the western part of San Francisco, the limit of flight seeming to be about 30 miles. The group going down the Tiburon peninsula jumps to Angel Island, then to Alcatraz Island, and proceeds as far south as Palo Alto (a distance of almost 50 miles) and probably farther. In one year a few stragglers were traced into the hills back of Los Gatos, about 75 miles.

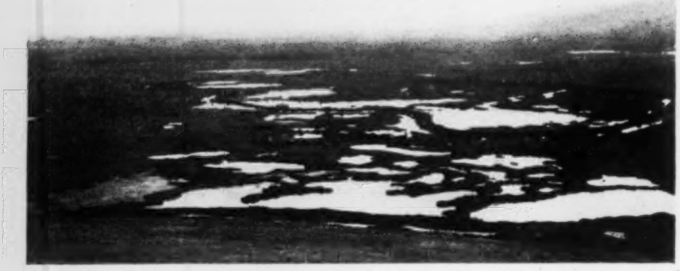
The duration of these migrations is about a month or six weeks, and during their progress all warm-blooded animals, man included, are tremendously annoyed by the aggressive and persistent attacks of the mosquitoes. Outdoor industry and agriculture are hampered, and outdoor recreation of any kind is practically unendurable.

CONTROLLING THE SALT-MARSH MOSQUITO

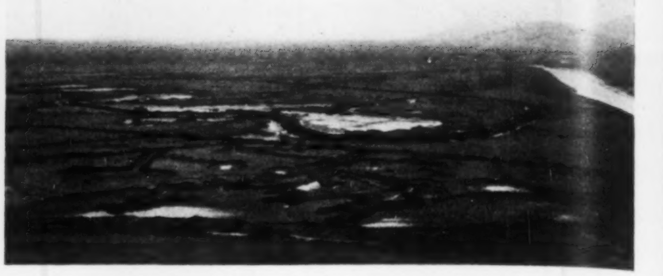
The control of the salt-marsh species is simple in principle, but complex in detail. Any one of three general methods of control may be used successfully:

1. Ditching the breeding marsh so as to permit the free ebb and flow of daily tidewater to all parts of the marsh, leaving no permanent pools in which mosquitoes can breed.
2. Drying up the marsh by enclosing it with a dike, and providing outlet structures to permit outflow at low tide without return flow at high tide.
3. Maintaining a constant water level in the marsh by enclosing it with a dike and providing both inlet and outlet structures with weirs so as to give a good circulation of water. Stocking with *Gambusia affinis* (the top minnow), which can be adapted to brackish water, is an effective auxiliary measure.

Any one of these three methods of control requires continuous maintenance to be effective. Dikes, inlet and outlet structures, and drains must be kept in good repair and effective working order. Under most condi-



A Typical Mosquito-Breeding Salt Marsh Before Draining



The Same Marsh with Pools Emptied by Ditches at Low Tide

ELIMINATION OF PERMANENT POOLS CONTROLS SALT-MARSH MOSQUITOES

tions a small amount of oiling may also be required to "mop up" larvae which may occur in slow-moving water in drain ditches, or in isolated areas difficult to drain effectively. As a rule, oiling of salt marshes without preliminary drainage is uneconomical, and only partially effective.

The migrating *Aedes* species of the great plains are terrific pests. *Aedes vexans* and *Aedes spencerii* are typical of these, *Aedes vexans* also being prominent in the Pacific Coast valleys. They are generally flood-water mosquitoes, appearing in the spring after the principal snow melt or flood runoff. They usually have but one brood per year, some of the adults persisting even into the autumn. Their control requires widespread and intense activity in the spring to get a quick removal of the residual water left in pools after subsidence of the spring runoff, and to oil any residual breeding pools.

Similar species of mosquitoes, such as *Aedes increpitus, Aedes hexodontus, Aedes ventrovittus*, and *Aedes communis*, make mountainous areas quite unpleasant. Their control is usually rather difficult, especially as the larvae appear while the snows are melting. Drainage of mountain meadows will help to reduce the breeding areas, but oiling will probably be the principal control measure. We have found that oiling all pools in a mountainous region, whether there are mosquito larvae in them or not, so discourages egg deposition that good control can be had by oiling only in alternate years.

Even though handicapped by arbitrary restrictions in some cases, the National Park Service has been doing excellent work in reducing the breeding of mosquitoes. The efficiency of their methods may be open to question in some instances, but as a whole public enjoyment of these recreational areas has been much enhanced.

SUBARCTIC MOSQUITOES CREATE DIFFICULT PROBLEM

The subarctic species of mosquitoes encountered in northern Canada and Alaska are without question the greatest pests of all. Their tremendous numbers in the short arctic summer make life nearly unendurable for both men and animals. Some of these species are *Aedes stimulaus, Aedes aldrichi, Aedes flavescens, Aedes alpinus, Aedes aborigenes*, and *Aedes palustrus*. Their abatement will be difficult and expensive, and is probably practicable only in the vicinity of the larger settlements. Drainage of tundra, where much of this breeding occurs, may not be sufficiently effective to justify the cost. I am inclined to believe that the only reasonably economical control method may be the application of oil to extensive breeding areas by means of airplanes. But until practical control measures are tried out by skilled entomologists and engineers, we will have little valid information as to the best methods and their costs.

Mosquito breeding under tropical conditions is usually so intense and varied as to make impossible any general discussion of the problem within a reasonable space. The disease-vector problem is so much more important than the pest problem that most abatement procedures confine themselves to the control of the disease carriers. Sustained high temperatures, frequent rainfall, high humidity, and rapid growth of vegetation, make mosquito abatement work in the tropics difficult, costly, and precarious. The work is usually limited by the amount of money which can be afforded for disease-prevention only. Given sufficient money, it has been demonstrated that it is possible to make limited areas in the tropics practically free from mosquito-transmitted disease, and also reasonably comfortable through the reduction of pest mosquitoes to endurable numbers.

The control of disease-bearing mosquitoes has been generally a function of local and state health departments, and, where not too narrowly limited financially, these departments have accomplished satisfactory results in the reduction of malaria, yellow fever, and dengue. But owing to a limited viewpoint, health departments have given little or no attention to the abatement of pest mosquitoes. As a result there has been formed under special state enabling acts in the United States a separate political entity generally known as the "mosquito abatement district." At the present time New Jersey, New York, Illinois, California, Florida, Utah, Rhode Island, Mississippi, and possibly other states have such acts. Usually the districts are formed to abate pest mosquitoes, though in some cases they have been used for malaria control.

On the whole, these districts have achieved results of great economic value, and New Jersey and California, through annual conferences, have contributed greatly to the advancement of the technical and scientific aspects of the work. On the whole, the districts have been fairly free from political interference, and as their work has usually been supervised by competent entomologists and civil engineers, it has been reasonably efficient.

Today it is possible to make some encouraging statements. In subarctic regions, at least in limited areas, reasonably satisfactory control of pest mosquitoes can be obtained under skilled direction, at costs which we cannot now predict for lack of adequate large-scale data. In limited areas of tropical regions, mosquito-transmitted disease can be reduced to a matter of minor significance, and physical comfort against mosquito bites maintained in a satisfactory degree, at a cost which is not prohibitive. Finally, in the temperate zone, mosquito-transmitted disease can be eliminated and physical comfort against pest mosquitoes assured at a cost which is quite moderate and thoroughly justifiable.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Stadia Rod Long in Use

Dear Sir: Credit for originating the stadia rod design referred to by G. J. Swartz, Jun. Am. Soc. C.E., in the May issue, should go to J. C. L. Fish, M. Am. Soc. C.E., who developed essentially the same arrangement in 1902 and described it in *Engineering News* for October 1909. The writer first made use of it in 1910 for plane table work on the Big Wood River irrigation project in southern Idaho.

This design was also used on the Big Wood project for staff gages on canal and river stations, where great accuracy was not required. This latter use developed an odd kink in human nature. In an attempt to overcome the tendency of lay gage readers to report the footmark above the water surface instead of the mark below the surface, particularly in turbid water, the writer inverted several of the gages and instructed the readers to report the distance from the zero to the water surface. Results were excellent as far as the lay readers were concerned, but the engineers found the inverted gage scale on discharge curves and tables too confusing.

Lothrop Crosby, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Water Division,
Department of Public Utilities

Tacoma, Wash.
August 23, 1936

The Municipal Bridge at St. Louis

To the Editor: I am very grateful to Howard C. Baird, M. Am. Soc. C.E., for the additional information on the Municipal Bridge at St. Louis, which he gives, in the August issue, in his discussion of my article on "Some Features of the Mississippi Bridges," in the June issue of Civil Engineering. I also appreciate his correction of two errors in the description of the structure, which were due to not having carefully studied the complete data on this important bridge.

The omission of this information and of the engineers' names was entirely unintentional, and I regret that they did not appear in my original article.

Harry J. Engel, Jun. Am. Soc. C.E.
Assistant Engineer, Modjeski, Masters and Case, Inc.

Philadelphia, Pa.
August 28, 1936

The Engineer and Social Progress

To the Editor: Being unable to attend the Portland Convention, I was interested in reading President Mead's address, "The Engineer and His Code," in the August issue of Civil Engineering. For many years I have been particularly concerned about the relatively unimportant position which the engineering profession occupies in social planning. Dr. Mead is absolutely right in condemning the doctrine of scarcity and high prices, and proposing the doctrine of plenty to supplant it. But it seems to me that no specific methods for enlisting the profession in the battle against poverty and unemployment were proposed. Surely the difficulties in attaining that "nice adjustment between service and self" can hardly be satisfactorily overcome by an amplified code of ethics to include "the best thoughts on the duties of the engineer in all his activities."

It is appalling to realize the impotence of the professions in the face of unemployment and the astounding fact of poverty in the midst of plenty. How can engineers actively organize the necessary forces to obtain control over this country's vast capacity for production and for distribution? Are we to continue to depend on the outworn principle of "rugged individualism" in the new age? It is doomed to failure. By the very nature of the complexity of modern life, some form of collective control and central planning is a necessity. Why are not engineers in greater number taking their rightful places as far-sighted men of vision?

Such men as Arthur E. Morgan, M. Am. Soc. C.E., and Morris L. Cook and their magnificent work with the Tennessee Valley Authority and the Rural Electrification Commission point the way for the future. The Third World Power Conference being held in Washington this month (September) brings together engineers, economists, public officials, corporation heads, and spokesmen for labor and consumer. Engineers should foster similar economic conferences and should participate in them more generally. The importance of such conferences should be increased so that public confidence in the ability of professional men to meet and solve the problems of poverty and unemployment will result. Activities of this kind, especially at the present time, are of more importance than some of the papers and discussions at meetings of the Society.

Whether the rank and file of engineers will be forced into alliance with labor, by the formation of labor unions, in order to attain some measure of power will depend on the future action of the leaders of our professional societies. Without reference to the political campaign this fall, I am profoundly convinced that for the immediate future the great struggle in this country is between the principle of democracy and the principle of dictatorship. And there cannot be complete political democracy without economic democracy, as is so clearly shown in Lincoln Steffen's *Autobiography*. I appeal to younger engineers to apply their intelligence, both individually and collectively, to the solution of the problem of how to develop a practical working system of cooperation, whereby poverty and unemployment can be completely eliminated. Answers already suggested are the development of new inventions and "low-price technics," new methods for distributing the benefits of the already existing productive power, and the release of our as yet undeveloped capacity for social engineering.

J. P. J. Williams, M. Am. Soc. C.E.
Civil Engineering Department, Cooper Union

New York, N.Y.
Sept. 7, 1936

Educational Survey—Importance of Graduate Study

To the Editor: The comment by H. P. Hammond, M. Am. Soc. C.E., in the September issue, is a timely criticism of the summary article on the survey of the engineering profession, published in the June issue of the *Monthly Labor Review* and abstracted in the August issue of Civil Engineering.

The main point of this criticism is in connection with the statement that "Graduate study in engineering does not appear to be of any considerable importance as a prerequisite to practice in the engineering field." While this conclusion derives from a summary of all reports, it is recognized that in certain fields the graduate degree has already attained importance—a situation that will be amply developed in the full report. The reports to the Bureau of Labor Statistics will also confirm the extension of graduate work in the last decades. Thus, of the total number of all engineering graduates for the period 1925–1929, those who reported post-graduate work in this survey constituted 10.2 per cent as compared with 6.6 per cent of those graduating prior to 1905. In the very near future, we will publish these data, supplemented by those contained in the survey of graduate study by the Society for the Promotion of Engineering Education.

Andrew Fraser, Jr.
Division of Wages, Hours, and
Working Conditions, U. S.
Department of Labor

Washington, D.C.
September 11, 1936

Proper Live Load for Stadiums

TO THE EDITOR: In closing discussion on my article on "The Bessemer High School Stadium," in the December 1935 issue of CIVIL ENGINEERING, I should like to clarify certain statements—namely, that "Stadium decks are generally designed for a total load of not over 110 lb per sq ft" and that, "A stand loaded to capacity carries an average live load of 40 lb per sq ft." These statements seem to have been misinterpreted and subject to some criticism.

In order to clarify the statements, it is necessary to point out, first, that the article was written in connection with the design of a steel plate deck, which weighs approximately 10 lb per sq ft. The reference to 110 lb, therefore, was intended to reflect the standard practice of a live load of 100 lb per sq ft. The word "capacity" refers to normal or rated capacity.

In the May 1936 issue of CIVIL ENGINEERING, Gavin Hadden, M. Am. Soc. C.E., states that in his belief, my statements are "dangerous," and both Mr. Hadden and James R. Griffith,* M. Am. Soc. C.E. (CIVIL ENGINEERING, August 1936), state that even a live load of 110 lb per sq ft is "inadequate."

My statement that the actual average live load is only 40 lb per sq ft, is certainly no more dangerous than F. E. Kidder's statement that the average live load in a school room is 13 lb per sq ft, and that in a theater, assuming an opera chair at 35 lb, the average live load is only 44 lb per sq ft (Kidder's *Architects' and Builders' Pocket Book*). A stadium deck will normally average from 4 to 5 sq ft per spectator. Allowing 15 lb for the weight of a seat will result in an average live load not exceeding 40 lb per sq ft. These statements are true, and the danger lies only in their misuse.

As a member of the Sectional Committee, Safety Code for Grandstands of the American Standards Association, I have examined extracts from a large number of building codes. None of these require live loads in excess of 100 lb per sq ft. The city of Indianapolis permits a live load of 60 lb per sq ft. Mr. Griffith refers to live loads for assembly halls, schools, and colleges, as given in the *Carnegie Pocket Companion*. Of the 22 cities there listed, only five require a live load in excess of 100 lb per sq ft for college assembly halls. All these five permit 100 lb or less for grandstands. The U. S. Department of Commerce and the National Board of Fire Underwriters both specify 100-lb live load for grandstands.

In a thorough consideration of the proper live load to be used for stadium structures, it is necessary to make a sharp distinction between the seating area and the aisles, walkways, ramps, and other passageways. The seating area consists of a stepped structure with fixed seats. Such a structure certainly does not present the possibility of crowding or mass formations that exists in assembly halls. The effect of spectators jumping suddenly from their seats will produce an impact, which in a normally loaded stand might be as high as 100 per cent. If it should happen that any part of the seating area becomes 100 per cent overcrowded, this impact could not apply, as the spectators would then be on their feet continuously. On the other hand, it is possible to secure live loads in excess of 100 lb per sq ft on floors, as has been pointed out through various experiments. Intense crowding of spectators at the exits would indicate the wisdom of providing for a live load of not less than 125 lb per sq ft for all aisles, walkways, ramps, and stairs.

Mr. Griffith has referred to the rhythmic vibration that accompany cheering. It is very doubtful if this seriously affects the vertical loading. It does, however, produce a considerable sway, either longitudinally or transversely. The sway produced by concerted movement of spectators was measured by experiments of the American Standards Association, and found to amount to approximately 24 lb per lin ft of seats longitudinally, and 9 lb per lin ft of seats transversely.

W. N. WOODBURY, M. Am. Soc. C.E.
Division Engineer, Virginia Bridge Company

Birmingham, Ala.
August 22, 1936

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* *Editor's Note: Mr. Griffith calls attention to the following correction to the last sentence of his letter. The services of design and supervision of construction of the Northwestern University stadium were furnished by James Gamble Rogers, architect—Gavin Hadden, M. Am. Soc. C.E., engineer, associate. The resident engineer was George F. Baker, Assoc. M. Am. Soc. C.E.; Mr. Griffith was one of his assistants.*

Standing Wave Flume Used in India

DEAR SIR: In the article in the April issue, entitled "Discharge Characteristics of the Free Overfall," by Hunter Rouse, Assoc. M. Am. Soc. C.E., it is stated that no satisfactory degree of success has been attained with critical depth water meters.

Details of the "standing wave flume," a critical depth meter, used with considerable success in India for measuring and controlling irrigation water, may therefore be of interest. This has been developed by C. C. Inglis, Bombay Presidency, from an early design by E. S. Crump, Punjab.

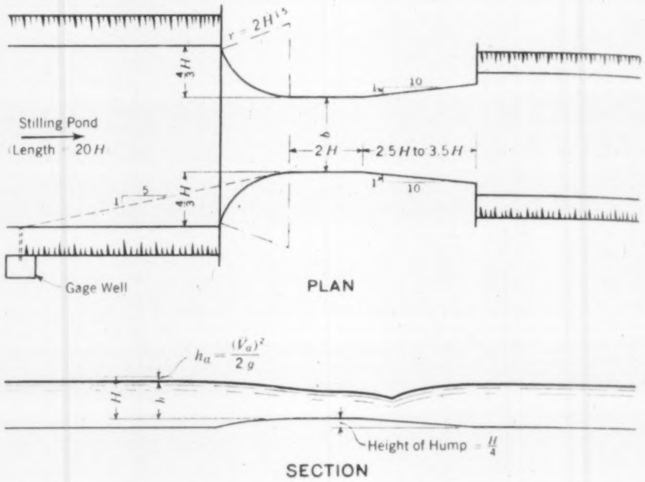


FIG. 1. STANDING WAVE FLUME STANDARDIZED IN THE BOMBAY PRESIDENCY

Dimensions Are in Terms of Full Supply Depth

The standing wave flume (Fig. 1) comprises a curved contraction; a throat, with hump in bed, in which the velocity is hypercritical; and a downstream divergence in which a standing wave forms and velocity head is reconverted into static head. The discharge is calculated from the upstream depth by the formula, $Q = cbH^{1.5}$, in which c varies from 3.00 to 3.09 according to the dimensions of the flume. The length and width of the throat are about twice the full supply depth. If the width of channel is large compared with the depth two or more flumes are used, side by side.

Up to now a stilling pond has usually been provided upstream, in which case field results are correct to within ±2 per cent for a range of discharge from 0.1 to 1.4 full supply discharge. This is found ample in practice for normal conditions. Where greater accuracy is required, a standard 2-ft flume is used, this design having been carefully calibrated by measuring tank. This is accurate to less than ±0.5 per cent. The stilling pond may, however, be omitted, in which case allowance must be made for velocity of approach.

A. R. THOMAS

Poona, India
August 3, 1936

Again, Hoover Dam?

DEAR SIR: A year ago (July 1935 issue) Past-President Hunter McDonald questioned the propriety of the designation of Boulder Dam. I believe that members of the Society can do much to correct the injustice of the present situation and to maintain the dignity of the profession, as well as to show our respect for an honorary member of this Society, in the matter of the name of this dam in Black Canyon on the Colorado River.

If each of us, who has the interest and independence to do so, will call it the Hoover Dam orally and in writing, the practice will extend, as it should, and become general. Those meticulously inclined might insert the words "Boulder Dam" in parentheses.

W. W. CROSBY, M. Am. Soc. C.E.
Consulting Engineer

Coronado, Calif.
Sept. 7, 1936

Fall Meeting in Pittsburgh, Pa.

Arranged by the Pittsburgh, Cleveland, and Central Ohio Sections of the Society

William Penn Hotel to Be Headquarters for Gathering, October 13–16, 1936

Opening Session and General Meeting

TUESDAY—October 13, 1936—Morning

9:00 **Registration**

10:00 **Fall Meeting called to order by**

CLIFFORD G. DUNNELLS, *M. Am. Soc. C.E., President, Pittsburgh Section, Am. Soc. C.E.*

10:05 **Address of welcome**

HIS HONOR, WILLIAM N. MCNAIR, *Mayor of the City of Pittsburgh*

DR. ROBERT E. DOHERTY, *President, Carnegie Institute of Technology, Pittsburgh, Pa.*

10:30 **Response**

DANIEL W. MEAD, *President, American Society of Civil Engineers.*

SYMPOSIUM ON FLOOD CONTROL

Because of the great damage done by the floods of 1936 in areas not previously seriously affected, this symposium has been arranged to place before the profession facts concerning the recent floods and the measures recommended for future prevention and for minimizing the damage, should they occur.

SESSION I

Tuesday Morning

DANIEL W. MEAD, *President, Am. Soc. C.E., Presiding*

10:40 **The Flood of 1936 in the Eastern Part of the United States**

THE HONORABLE JAMES J. DAVIS, *U. S. Senator from Pennsylvania*, Pittsburgh, Pa.

SESSION II

Tuesday Afternoon

HENRY E. RIGGS, *Vice-President, Am. Soc. C.E., Presiding*

2:00 **Problems in Developing a National Flood Protection Policy**

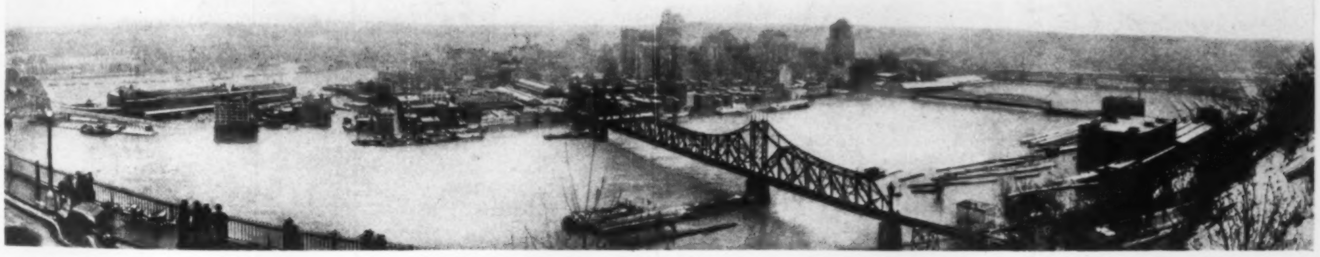
ABEL WOLMAN, *M. Am. Soc. C.E., Chairman, Water Resources Committee, National Resources Committee*, Baltimore, Md.

3:00 **The Economic Aspects of Flood Control**

NATHAN B. JACOBS, *M. Am. Soc. C.E., President, Morris Knowles, Inc.*, Pittsburgh, Pa.

4:00 **General discussion**

PITTSBURGH TRIANGLE BEFORE THE FLOOD



AT THE HEIGHT OF THE FLOOD, APRIL 18, 1936

TUESDAY—October 13, 1936—Evening

Smoker for Men—Special Entertainment for the Ladies

Members and men guests will be entertained at a Smoker at the William Penn Hotel. The ladies will be entertained at a party consisting of motion pictures and a floor show at the William Penn Hotel. There will be refreshments afterwards. Tickets for the Smoker are $1.25 each. There will be no charge for tickets to the ladies' entertainment.

Sessions of Technical Divisions Occupy Two Days

WEDNESDAY—October 14, 1936

CONTINUATION OF SYMPOSIUM ON FLOOD CONTROL UNDER AUSPICES OF WATERWAYS DIVISION

SESSION III

Wednesday Morning

W. G. ATWOOD, *M. Am. Soc. C.E., Chairman, Waterways Division, Am. Soc. C.E., Presiding*

10:00 **New England Floods**

W. F. UHL, *M. Am. Soc. C.E., Hydraulic Engineer, Chas. T. Main, Inc.*, Boston, Mass.

10:40 **New York State Floods**

A. W. HARRINGTON, *M. Am. Soc. C.E., District Engineer*, and HOLLISTER JOHNSON, *Assoc. M. Am. Soc. C.E., Hydraulic Engineer*, U. S. Geological Survey, Albany, N.Y.

11:20 **Discussion**

New England Floods

HUGH J. CASEY, *M. Am. Soc. C.E., Captain, Corps of Engineers, U. S. Army, U. S. Engineer Office*, Boston, Mass.

New York State Floods

E. L. DALEY, *M. Am. Soc. C.E., Colonel, Corps of Engineers, U. S. Army; District Engineer*, New York, N.Y.

SESSION IV

Wednesday Afternoon

W. G. ATWOOD, *M. Am. Soc. C.E., Presiding*

2:00 **Floods in the Upper Ohio and Tributaries**

E. K. MORSE, *M. Am. Soc. C.E., Consulting Engineer*, Pittsburgh, Pa.; and HAROLD A. THOMAS, *M. Am. Soc. C.E., Professor, Department of Civil Engineering, Carnegie Institute of Technology*, Pittsburgh, Pa.

2:45 **An Ideal Organization for the River and Flood Service of the Weather Bureau**

MONTROSE W. HAYES, *Esq., Chief, River and Flood Division, U. S. Weather Bureau*, Washington, D.C.

3:00 **Federal Plans for Flood Control**

W. E. R. COVELL, *Lieutenant Colonel, Corps of Engineers, U. S. Army; U. S. District Engineer*, Pittsburgh, Pa.

3:45 **Discussion**

Floods in the Upper Ohio and Tributaries

T. T. KNAPPEN, *M. Am. Soc. C.E., Senior Engineer, North Atlantic Division, U. S. Engineers*, New York, N.Y.

Federal Plans for Flood Control

M. C. TYLER, *M. Am. Soc. C.E., Brigadier General, Corps of Engineers, U. S. Army; Assistant to the Chief of Engineers, War Department*, Washington, D.C.

CHICOPEE FALLS, MASS., DURING 1936 FLOOD

SYMPOSIUM ON ECONOMIC ASPECTS OF ENERGY GENERATION

Power Division and Engineering-Economics and Finance Divisions, Am. Soc. C.E.

The social and political aspects of the power problem have received much emphasis in recent years. It is with the conviction that no sound solution can be found which does not rest upon sound engineering and economic principles, that this symposium has been sponsored by the Power and Engineering-Economics and Finance Divisions of the Society. The status of the technical advance in generation and utilization will be discussed in three addresses, to be followed by analysis in the cost of generation and finally by a discussion of the economic and social aspects of the problem in the light of the preceding discussions.

SESSION I

Wednesday Morning

FREDERICK W. DOOLITTLE, *M. Am. Soc. C.E., Chairman, Power Division, Am. Soc. C.E., Presiding*

10:00 **Thermo-Generation of Energy**

GEORGE A. ORROK, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

10:30 **Hydro-Generation of Energy**

F. H. ROGERS, *Esq., Chief Engineer, I. P. Morris Division, Baldwin-Southwark Corporation*, Philadelphia, Pa.

11:00 **Improvements in Utilization of Energy**

JOEL D. JUSTIN, *M. Am. Soc. C.E., Consulting Engineer*, Philadelphia, Pa.

11:30 **General discussion**

SESSION II

Wednesday Afternoon

EDWIN F. WENDT, *M. Am. Soc. C.E., Chairman, Engineering-Economics and Finance Division, Am. Soc. C.E., Presiding*

2:00 **Cost of Generation of Energy**

PHILIP SPORN, *Esq., Engineer, American Gas and Electric Company*, New York, N.Y.

2:45 **Economic Aspects of Energy Generation**

RALPH A. FREEMAN and B. A. THRESHER, *Esquires, Professors, Department of Economics and Social Science, Massachusetts Institute of Technology*, Cambridge, Mass.

3:30 **General discussion**

McKees Rock Bridge

WEDNESDAY—October 14, 1936

SYMPOSIUM ON STRUCTURAL APPLICATION OF STEEL AND LIGHT-WEIGHT ALLOYS

Structural Division and Pittsburgh Section, Am. Soc. C.E.

The Structural Division has standing committees concerned, respectively, with (1) the laboratory and mathematical aspects of the use of structural materials, and (2) the structural properties and advantages of the newer, or "special," structural metals. Under the direction of these committees this symposium has been arranged with a view to surveying and recording, for the benefit of structural engineers, the status of present knowledge and outlook in these fields. From these papers and the ensuing discussions it is hoped to establish and organize in the most useful direction, the future work of the Division committees.

Session I

Wednesday Morning

Jonathan Jones, *M. Am. Soc. C.E., Chairman, Structural Division, Am. Soc. C.E., Presiding*

MODERN STRESS THEORIES AND FATIGUE RESEARCH

10:00 **Modern Stress Theories**

A. V. Karpov, *M. Am. Soc. C.E., Designing Engineer, Aluminum Company of America*, Pittsburgh, Pa.

10:30 **Tests of Engineering Structures and Their Models**

R. L. Templin, *M. Am. Soc. C.E., Chief Engineer of Tests, Aluminum Company of America*, New Kensington, Pa.

11:00 **Photo-Elastic Determination of Stress**

J. H. A. Brahtz, *Esq., Engineer, U. S. Bureau of Reclamation*, Denver, Colo.

11:30 **General discussion**

Session II

Wednesday Afternoon

Jonathan Jones, *Presiding*

METALLURIGICAL ASPECTS OF FERROUS AND LIGHT-WEIGHT ALLOYS OF INTEREST IN STRUCTURAL DESIGN AND FABRICATION

2:00 **Metallurgical and Manufacturing Aspects of Structural Ferrous Alloys**

(1) **Low-Alloy Structural Steels**

E. C. Bain, *Esq. Assistant to Vice-President, U. S. Steel Corporation*, New York, N.Y.; and Fred T. Llewellyn, *M. Am. Soc. C.E., Research Engineer, U. S. Steel Corporation*, New York, N.Y.

(2) **Stainless High-Alloy Structural Steels**

M. J. R. Morris, *Esq., Chief Metallurgical Engineer, Republic Steel Corporation*, Massillon, Ohio.

3:00 **Light-Weight Structural Alloys**

Zay Jeffries, *Esq., Consultant, General Electric Company and Aluminum Company of America*, Cleveland, Ohio; C. F. Nagel, Jr., *Esq., Chief Metallurgist, Fabricating Division, Aluminum Company of America*, Pittsburgh, Pa; *and* R. T. Wood, *Esq., Chief Metallurgist, Magnesium Corporation*, Cleveland, Ohio.

3:30 **Corrosion in Relation to Engineering Structures**

James Aston, *Esq., Metallurgist*, Pittsburgh, Pa.

4:00 **General discussion**

WEDNESDAY—October 14, 1936—Afternoon

SYMPOSIUM ON THE STATE SYSTEM OF PLANE COORDINATES

Surveying and Mapping Division and Pittsburgh Section, Am. Soc. C.E.

The necessity for more accurate and lasting surveys is being more fully recognized and has led engineers to realize the importance of having private and municipal surveys tied in with the national triangulation survey in order to perpetuate their use and avoid legal controversies arising from inaccurate and uncontrolled surveys.

The Symposium on the State-Wide Systems of Plane Coordinates will consist of a discussion of the need of such tying-in for the computation of local engineering projects based on the federal control surveys. A discussion of the initiation of such state systems and the benefits to be derived therefrom will tend to emphasize their usefulness in standardizing local survey practice. Some attention will also be given to their use in cadastral surveying in aiding to perpetuate property boundaries.

The use and advantages of the state system of plane coordinates will be presented outlining the method by which the advantages of the national triangulation system can be applied to local surveys by standard methods of plane surveying. The commercial application of coordinates in surveys will be reviewed, showing the importance of controlled surveys.

William Bowie, *M. Am. Soc. C.E., Chairman, Surveying and Mapping Division, Am. Soc. C.E., Presiding*

2:00 **State-Wide Systems of Plane Coordinates**

Oscar S. Adams, *Esq., Senior Mathematician, U. S. Coast and Geodetic Survey*, Washington, D.C.

3:00 **Discussion opened by**

Philip Kissam, *Assoc. M. Am. Soc. C.E., Associate Professor, Civil Engineering, Princeton University*, Princeton, N.J.

E. F. Coddington, *M. Am. Soc. C.E., Professor, Ohio State University*, Columbus, Ohio.

3:30 **Triangulation of Fairmont Region and Commercial Application of Coordinates in Surveys**

L. E. Yoder, *Esq., Civil and Mining Engineer, Consolidation Coal Company, Inc.*, Fairmont, W.Va.

4:00 **General discussion**

THURSDAY—October 15, 1936

SYMPOSIUM ON STREAM POLLUTION

Sanitary Engineering Division and Cleveland Section, Am. Soc. C.E.

In accord with a recent tendency toward appraisal of all aspects of conservation and proper utilization of water resources, the Symposium on Stream Pollution in the Ohio River Valley will concern itself with past progress in sanitation in that important watershed, with critical problems now existing, with the outlook for coordinated planning for needed works, and the possibility of securing their enablement. The long experience of existing agencies for planning will be reviewed. Emphasis will be on the adequacy of engineering organizations in initiating needed projects and in properly relating them to area needs, as distinct from their competence in technical matters in the realm of design or treatment.

SESSION I

Thursday Morning

GEORGE E. BARNES, *M. Am. Soc. C.E., Chairman of the Cleveland Committee on the Sanitary Engineering Division Program, Presiding*

10:00 Introduction

GEORGE E. BARNES, *M. Am. Soc. C.E., Head, Department of Civil Engineering, and Professor of Hydraulic and Sanitary Engineering, Case School of Applied Science,* Cleveland, Ohio.

10:05 What Can We Do About Stream Pollution?

ABEL WOLMAN, *M. Am. Soc. C.E., Chairman, Water Resources Committee, National Resources Committee,* Baltimore, Md.

10:30 Progress in Stream Pollution Control in the Ohio River Basin

E. S. TISDALE, *Esq., Director, Division of Sanitary Engineering, Department of Health,* Charleston, W.Va.

10:55 Stream Pollution Problems at Cincinnati, Ohio

J. E. ROOT, *M. Am. Soc. C.E., Director, Department of Public Works,* Cincinnati, Ohio.

11:20 Discussion by

FREDERICK H. WARING, *M. Am. Soc. C.E., Chief Engineer, State Department of Health,* Columbus, Ohio.

SESSION II

Thursday Afternoon

GEORGE E. BARNES, *Presiding*

2:00 Planning for Pollution Control at Pittsburgh

DANIEL E. DAVIS, *M. Am. Soc. C.E., Engineer (The Chester Engineers),* Pittsburgh, Pa.

2:25 Discussion by

HENRY D. JOHNSON, JR., *Assoc. M. Am. Soc. C.E., Chief Engineer, Department of Public Works,* Pittsburgh, Pa.

CHARLES M. REPPERT, *M. Am. Soc. C.E.,* Pittsburgh, Pa.

2:45 The Pymantuming Reservoir as a Factor in Low-Water Control

CHARLES E. RYDER, *Esq., Chief Engineer, Water and Power Resources Board, Pennsylvania Department of Forests and Waters,* Harrisburg, Pa.

3:10 Discussion by

DR. KARL IMHOFF, *M. Am. Soc. C.E., Chief Engineer, Ruhr Verband,* Essen, Germany.

3:20 Floods and Pollution

W. L. STEVENSON, *M. Am. Soc. C.E., Chief Engineer, Pennsylvania State Department of Health,* Harrisburg, Pa.

3:45 Discussion by

ROBERT SPURR WESTON, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass.

CHARLES A. HOLMQUIST, *Esq., Director, Division of Sanitation, State Department of Health,* Albany, N.Y.

4:15 Surveys for Pollution and Dilution Requirements

H. W. STREETER, *M. Am. Soc. C.E., Senior Sanitary Engineer, U. S. Public Health Service,* Cincinnati, Ohio.

4:40 Discussion by

DANIEL E. DAVIS, *M. Am. Soc. C.E., Engineer (The Chester Engineers),* Pittsburgh, Pa.

L. S. MORGAN, *Esq., District Engineer, Pennsylvania State Department of Health,* Greensburg, Pa.

THURSDAY—October 15, 1936

SYMPOSIUM ON MODERN HIGHWAY DESIGN AND CONSTRUCTION

Highway Division and Central Ohio Section, Am. Soc. C.E.

SESSION I

Thursday Morning

JULIUS ADLER, *M. Am. Soc. C.E., Chairman, Highway Division, Am. Soc. C.E., Presiding*

10:00 Important Considerations in Modern Highway Design

W. V. BUCK, *M. Am. Soc. C.E., Senior Highway Engineer, U. S. Bureau of Public Roads,* Columbus, Ohio.

Discussion opened by

H. D. BARNES, *M. Am. Soc. C.E., State Highway Engineer, State Highway Commission,* Topeka, Kans.

H. W. GIFFIN, *Assoc. M. Am. Soc. C.E., Field Engineer, State Highway Department,* Trenton, N.J.

10:30 Application of Soil Mechanics in Highway Construction

K. B. WOODS, *Jun. Am. Soc. C.E., Asst. Engineer, Bureau of Tests, State Highway Department,* Columbus, Ohio.

Discussion opened by

A. SCHOFER, *Assoc. M. Am. Soc. C.E., Associate Highway Engineer, Bureau of Public Roads,* Columbus, Ohio.

E. A. WILLIS, *Esq., Assistant Highway Engineer, U. S. Bureau of Public Roads,* Washington, D.C.

11:00 Design of Pavement Surfaces

H. F. CLEMMER, *M. Am. Soc. C.E., Engineer of Materials, Department of Highways, District of Columbia,* Washington, D.C.

11:00 General discussion

SESSION II

Thursday Afternoon

R. R. LITEHISER, *Assoc. M. Am. Soc. C.E., Chairman of the Central Ohio Committee on Highway Division Program, Presiding*

2:00 The Development of Highway Bridges in Ohio

WALTER G. SMITH, *M. Am. Soc. C.E., Field Bridge Engineer, State Department of Highways,* Columbus, Ohio.

2:30 Concrete Durability

H. S. MATTIMORE, *Assoc. M. Am. Soc. C.E., Engineer of Tests, Pennsylvania State Highway Dept.,* Harrisburg, Pa.

3:00 Weathering of Asphalt Pavements

MALCOLM S. DOUGLAS, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Case School of Applied Science,* Cleveland, Ohio.

3:30 Discussion opened by

THOMAS W. BRANNAN, *Jun. Am. Soc. C.E., Assistant Engineer, State Highway Department, Engineering Experiment Station, Ohio State University,* Columbus, Ohio.

THURSDAY—October 15, 1936

CONTINUATION OF SYMPOSIUM ON STRUCTURAL APPLICATION OF STEEL AND LIGHT-WEIGHT ALLOYS

Session III

Thursday Morning

Charles F. Goodrich, *M. Am. Soc. C.E., Member, Executive Committee, Structural Division, Am. Soc. C.E., Presiding*

STRUCTURAL APPLICATIONS OF SPECIAL STEELS

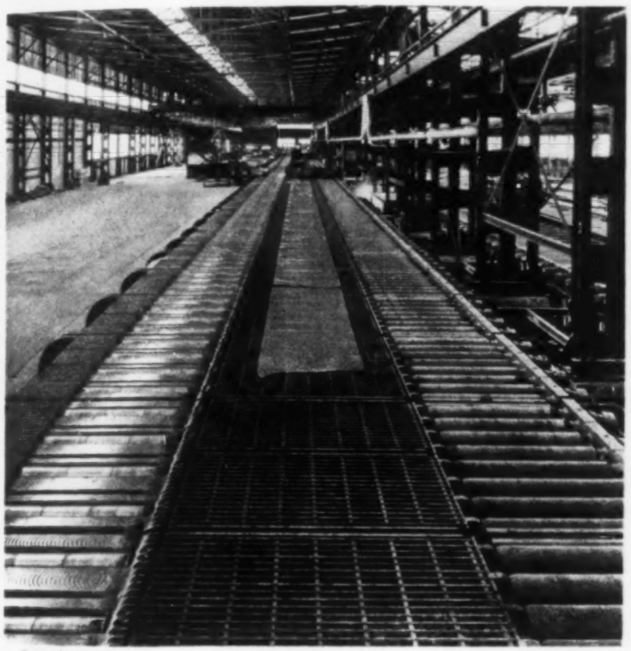
10:00 **Actual Applications of Special Structural Steels**

V. D. Beard, *M. Am. Soc. C.E., Designing Engineer, American Bridge Company,* Pittsburgh, Pa.

10:30 **Evolution of High-Strength Steels Used in Structural Engineering**

Leon S. Moisseiff, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

11:00 **General discussion**



© Bethlehem Steel Co.

Hot-Mill Building; New Addition to Lackawanna Plant, Bethlehem Steel Company

Session IV

Thursday Afternoon

Charles F. Goodrich, *Presiding*

LIGHT-WEIGHT STRUCTURAL DESIGNS

2:00 **Application of Stainless Steel in Light-Weight Construction**

E. J. W. Ragsdale, *Esq., Chief Engineer, Edward G. Budd Manufacturing Company,* Philadelphia, Pa.

2:30 **Structural Application of Aluminum Alloys**

E. C. Hartmann, *Assoc. M. Am. Soc. C.E., Research Engineer, Aluminum Company of America,* New Kensington, Pa.

3:00 **Magnesium Alloys and Their Structural Application**

A. W. Winston, *Esq., Metallurgical Department, The Dow Chemical Company,* Midland, Mich.

3:30 **General discussion**

THURSDAY—October 15, 1936

SYMPOSIUM ON VOLUME OF TRAFFIC AND FINANCIAL PROBLEMS INVOLVED IN THE PLANNING OF MAJOR HIGHWAYS

City Planning Division and Pittsburgh Section, Am. Soc. C.E.

The continuing growth of vehicular traffic has caused an insistent demand for the improvement of streets and highways to facilitate its movement and to reduce its hazards. Many of the important problems involved in designing a system of major highways deal, not with the roadway itself, but with its relationship to and effect upon adjoining properties. In congested districts these improvements are very costly and in other sections they may seriously affect existing property values. In this field city planners and highway engineers should cooperate. In the last 10 years over $100,000,000 has been spent in the Pittsburgh district on street and highway projects and in traffic safety studies and installations. The controlling factors, both physical and financial, will be described by engineers who took a leading part in these developments and will be discussed by others who have encountered similar problems throughout the nation.

Session I

Thursday Morning

Harold M. Lewis, *M. Am. Soc. C.E., Chairman, City Planning Division, Am. Soc. C.E., Presiding*

VOLUME OF TRAFFIC

10:00 **Division Business, Progress Reports of Division Committees**

10:30 **Factors Controlling Traffic Capacities in Existing Street Systems in Congested Districts**

Lewis W. McIntyre, *M. Am. Soc. C.E., President, Institute of Traffic Engineers,* Pittsburgh, Pa.

11:00 **Methods of Relieving Congestion and Increasing Capacity on Existing Street Systems**

Donald M. McNeil, *Jun. Am. Soc. C.E., Acting Traffic Engineer, City of Pittsburgh,* Pittsburgh, Pa.

11:30 **Discussion opened by**

Hawley S. Simpson, *M. Am. Soc. C.E., Research Engineer, American Transit Association,* New York, N.Y.

C. M. Pinckney, *M. Am. Soc. C.E., Chief Engineer of Public Works, Borough of Manhattan,* New York, N.Y.

Session II

Thursday Afternoon

John M. Rice, *M. Am. Soc. C.E., Chairman, Pittsburgh Committee on City Planning Sessions, Presiding*

ECONOMIC AND FINANCIAL PROBLEMS INVOLVED IN PLANNING OF MAJOR HIGHWAYS

2:00 **The Effect of a Major Highway on the District It Traverses**

U. N. Arthur, *M. Am. Soc. C.E., Formerly Chief Engineer, Department of City Planning, City of Pittsburgh,* Pittsburgh, Pa.

2:30 **Discussion opened by**

Gilmore D. Clarke, *M. Am. Soc. C.E., Consulting Landscape Architect,* New York, N.Y.

3:00 **Effects of Alignment, Grade, and Width on Direct and Indirect Costs of Major Highways**

Edward L. Schmidt, *Esq., Formerly Chief Engineer, Allegheny County Planning Department,* Pittsburgh, Pa.

3:30 **Relation of Highway Costs to Taxable Values and Community Wealth**

Joseph White, *Esq., Traffic Engineer, Allegheny County Department of Works,* Pittsburgh, Pa.

4:00 **General discussion**

Social Events and Entertainment

TUESDAY—October 13, 1936—Evening

Smoker for Men—Special Entertainment for the Ladies

9:00 p.m. Members and men guests will be entertained at a Smoker at the William Penn Hotel.

9:00 p.m. The ladies will be entertained by the Ladies' Committee at the William Penn Hotel. This entertainment will consist of motion pictures and a floor show. There will be refreshments afterwards.

Tickets for the Smoker are $1.25 each.

There will be no charge for tickets to the ladies' entertainment.

WEDNESDAY—October 14, 1936—Evening

8:00 p.m. Preview of International Art Exhibit

Through the courtesy of the officers of the Carnegie Institute arrangements have been made for members, ladies, and guests to visit the International Art Exhibit in advance of the official opening. Paintings are brought to Pittsburgh from all countries of the world, and the exhibition and the results of the award of prizes by world-known juries are landmarks in the development of art. Thus a unique opportunity will be offered to view this world-renowned art exhibition and to get in touch with Pittsburgh social circles. Local artists will act as guides to our members who would like to get more intimate glimpses of the exhibit.

10:00 p.m. After-Party

Following the visit to the art exhibit the group will be entertained at an after-party at the Chatterbox at the William Penn Hotel, where supper will be served.

There will also be dancing and a floor show.

There will be no charge for tickets to the art exhibit.

Tickets for the after-party are $1.25 each.

THURSDAY—October 15, 1936—Evening

7:00 p.m. Dinner Dance at the William Penn Hotel

Members, ladies, and guests will be entertained at a dinner dance held in the William Penn Hotel. Tickets for the dinner and evening's entertainment, including floor show, are $3.50 each.

ENTERTAINMENT FOR THE LADIES

While the members are busy attending the technical sessions, various events for the entertainment of the ladies are being planned by the Ladies' Committee.

TUESDAY—October 13, 1936—Afternoon

For the entertainment of ladies the Ladies' Committee has planned motor drives through the Schenley district and East Liberty.

WEDNESDAY—October 14, 1936—Morning and Afternoon

The ladies will leave the hotel late Wednesday forenoon for motor drives through the Highland Park district of Pittsburgh. The group will visit the plant of the H. J. Heinz Company, where a special luncheon will be served. In the afternoon they will return to the headquarters hotel by an interesting route.

THURSDAY—October 15, 1936—Afternoon

On Thursday afternoon the ladies will be entertained by motor drives through the Golden Triangle, the noted downtown district of Pittsburgh. The drive will also include visits to the residential districts of the North Side and the South Side. Opportunities will be given to visit the various department stores.

There will be no charge for any of the drives for ladies.

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CARNEGIE INSTITUTE, PITTSBURGH, PA.

All-Day Excursions on Friday

FRIDAY—October 16, 1936—All Day

Excursion No. 1

Excursion to the hydraulic laboratory of the Carnegie Institute of Technology and the plant of the Aluminum Company of America at New Kensington.

Excursion No. 1 will leave the William Penn Hotel at 9:30 a.m. and proceed to the Carnegie Institute of Technology Hydraulic Laboratory where models of the Tygart River Dam, the Emsworth Dam on the Ohio River, and several models of the Bluestone Dam will be seen in operation. Prof. Harold A. Thomas will describe the models and the tests that are being made. Leaving the Carnegie Institute this excursion will proceed by bus to the plant of the Aluminum Company of America at New Kensington, where lunch will be served and the following items of interest will be seen: A model of the Calderwood Arch Dam, models of various lattice structures, experimental Aluminum alloy bridge trusses, structural tests of stiffened flat and curved plates, various kinds of fatigue tests on Aluminum alloy at both room and elevated temperatures, creep tests of Aluminum alloys, impact tests on built-up structures of Aluminum alloys and steel, routine tension tests employing automatic autographic electrical extensometers, coefficient of friction tests between various metals at high pressure with and without lubrications. Inspection will be made of the extensive metallurgical and chemical laboratories.

There will be no charge for tickets.

Excursion No. 2

Excursion to the Homestead Plant of the Carnegie-Illinois Steel Corporation.

Excursion No. 2 will leave the William Penn Hotel at 9:30 a.m., going direct to the plant of the Carnegie-Illinois Steel Corporation at Homestead. Particular points of interest will be:

The operation of the open-hearth furnaces

Rolled structural shapes in the largest mill in the country

Rolling of plates, sheet piling, and other products

The manufacture of large forgings

Following the inspection, luncheon will be served.

For the afternoon, members of this party will have the choice of one of two trips as follows:

1. The Schoen Plant of the Company at McKees Rocks, where the manufacture of armored bridge floors and rolled steel wheels will be in operation, or

2. The hydraulic laboratory of the Carnegie-Institute of Technology, where models of the Tygart River Dam, the Emsworth Dam on the Ohio, and several models of the Bluestone Dam will be seen in operation.

There will be no charge for tickets.

Hotel Accommodations and Announcements

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Fall Meeting, paying for the rooms in advance for at least a part of the period during which they expect to be in Pittsburgh.

Hotel Rates

HOTELS	SINGLE ROOM		DOUBLE ROOM	
	With Bath	Without Bath	With Bath	Without Bath
William Penn Hotel	$3.00 up	......	$5.00 up	......
The Pittsburgher	3.00 up	......	4.50 up	......
Schenley Hotel	3.00 up	......	5.00 up	......
Keystone Hotel	2.50 up	......	3.50 up	......
Fort Pitt Hotel	2.50 up	......	4.00 up	......

The William Penn Hotel is the meeting headquarters, and it is expected will be able to care for all who attend.

Reservations are to be made directly with the hotel as early as possible in order to prevent delay and inconvenience in obtaining accommodations on arrival.

All who attend the Fall Meeting are requested to register immediately upon arrival at meeting headquarters. Special badges and tickets will be obtained at the time of registration.

When making reservations, state kind of room desired, that is, single room inside; single room outside; double room inside, double bed; double room outside, double bed; double room inside, twin beds; double room outside, twin beds. Hotel will make acknowledgement of reservation direct to member.

Information

A registration desk will be provided in the headquarters hotel to assist visiting members in securing any desired information about the city. At the registration desk, a card file of those in attendance will be maintained, with information as to members' hotel addresses in Pittsburgh.

Entertainment

Attention is directed to the program for the entertainment of the ladies. In addition, the ladies are expected to participate in all the other features of the meeting that may interest them.

Golf

The Men's Golf Committee has made arrangements with several of the country clubs for golf each day of the meeting. Arrangements to play golf may be made at the registration desk, through A. G. Clarke, chairman of the Golf Committee.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements.

See page 20 in back of this issue for registration and ticket order forms.

Local Section Conference

On Monday afternoon, October 12, 1936, there will be a conference of delegates from the Local Sections in the Fall Meeting Region with the Society's Committee on Local Sections.

A comprehensive agenda has been prepared for the discussion of activities of mutual interest to the Local Sections.

All interested members are invited to attend and participate in the conference.

Student Chapter Conference

At 2:00 p.m. on Thursday afternoon, October 15, 1936, will be held a conference of representatives from the Student Chapters. In addition to official representatives, as many members of Student Chapters as practicable, together with faculty advisers and contact members, are expected. The conference will be open to discussion of any subjects of interest to the Chapters, and after the meeting an abstract of the proceedings will be sent to every Chapter in the country. Members of Student Chapters are also invited to attend and participate in all the events of the Fall Meeting.

See Advertising Page 20 for Reservations and Ticket Orders

EXHIBIT OF ENGINEERING FOUNDATION ON IRON ALLOYS AND WELDING RESEARCHES

Of particular interest to structural engineers attending the meeting will be an exhibit in the William Penn Hotel of the research work of the Engineering Foundation being conducted by the Iron Alloys Committee and the Welding Research Committee. Both of these researches are cooperative enterprises of engineers and industries.

The alloys of iron research is at present occupied principally with the preparation of critical digests and bibliographies of the world literature in many languages and their publication in a series of books for metallurgists, engineers, and other persons interested in the production and use of iron, carbon steels, alloy steels, cast irons, and alloy cast irons. Some laboratory research also has been done.

The Welding Research Committee has a comprehensive program embracing critical reviews and digests of the world literature, translations of foreign articles for current use, researches on fundamental problems (in college laboratories), and extensive industrial researches dealing with all kinds of materials used in welding, methods of testing welds, analysis of failures, and causes and effects of weld stresses.

Mr. Frank T. Sisco, editor of the Iron Alloys Committee, will be the Engineering Foundation's representative in charge of the exhibit for furnishing information and literature to all interested.

Committees on Arrangements

General Committee

A. V. Karpov, *Chairman*

Pittsburgh Section: U. N. Arthur, W. H. Buente, John N. Chester, Robert A. Cummings, Allen S. Davison, R. P. Forsberg, E. N. Hunting, H. D. Johnson, Jr., Richard Khuen, Jr., J. F. Laboon, M. G. Mansfield, L. C. McCandliss, L. W. McIntyre, E. K. Morse, John M. Rice, L. J. Riegler, C. B. Stanton.

Cleveland Section: George E. Barnes, George B. Gascoigne.

Central Ohio Section: R. R. Litehiser, William E. Burroughs.

Finance Committee: W. F. Trimble, Jr., *Chairman;* George S. Baton, John N. Chester, Alexander Dann, John Farris, W. C. Hawley, E. N. Hunting, Richard Khuen, Jr., J. F. Laboon, John M. Rice.

Hotels and Registration Committee: Allen S. Davison, *Chairman;* L. P. Blum, C. G. Dunnells, C. K. Harvey, F. A. Pruitt, R. S. Quick, John M. Rice, W. A. Weldin.

Transportation Committee: R. P. Forsberg, *Chairman;* A. G. Butler, A. C. Clarke, W. C. Groves, J. F. Leonard.

College Committee: L. C. McCandliss, *Chairman;* A. Diefendorf, F. M. McCullough, C. B. Stanton.

Papers and Meetings Committee: A. V. Karpov, *Chairman;* George E. Barnes, C. F. Goodrich, R. R. Litehiser, F. M. McCullough, F. S. Merrill.

Program Committee: M. G. Mansfield, *Chairman;* V. R. Covell, C. N. Haggart, J. C. Kohl, George S. Richardson.

Flood Control Program Committee: E. K. Morse, *Chairman;* N. B. Jacobs, J. P. Leaf, George M. Lehman, C. M. Neeld, N. Schein, H. A. Thomas.

Entertainment and Excursion Committees

E. N. Hunting, *Chairman*

Charles Reppert, *Vice-Chairman*

Board of Directors Dinner Committee: Richard Khuen, Jr., *Chairman;* John N. Chester, Robert A. Cummings, George S. Davison, E. S. Fickes, R. P. Forsberg, A. V. Karpov, L. C. McCandliss, F. M. McCullough, David W. McNaugher, E. K. Morse, S. A. Taylor, T. J. Wilkerson, Marshall Williams.

Smoker Committee: L. W. McIntyre, *Chairman;* Robert A. Cummings, Jr., Alexander Dann, D. E. Davis, Allen S. Davison, A. R. Ellis, John Farris, W. H. Frick, C. N. Haggart, E. D. Harshbarger, F. W. Henrici, N. B. Jacobs, L. W. McIntyre, F. L. Metzger, B. H. Prack, F. W. Price, C. L. Wooldridge.

International Art Exhibit Committee: F. M. McCullough, *Chairman;* U. N. Arthur, C. S. Boardman, C. K. Harvey, R. T. Hyde, Mrs. A. V. Karpov, Alex. J. Costello, G. M. Lehman, Norwood McGillivary, Jas. L. Stuart, S. A. Taylor.

After-Party Committee: W. H. Buente, *Chairman;* W. E. Brown, Allen S. Davison, J. L. deVou, A. Diefendorf, H. N. Eavenson, Sam. Eckels, F. J. Evans, L. W. McIntyre, J. W. Rickey, H. A. Thomas, W. F. Trimble, Jr.

Dinner Dance Committee: F. L. Metzger, *Chairman;* G. S. Baton, H. H. Frank, H. D. Johnson, Jr., J. C. Kohl, J. F. Laboon, J. F. Leonard, F. A. Pruitt, George S. Richardson, C. B. Stanton, W. F. Trimble, Jr.

Excursions Committee: S. L. Fuller, *Chairman;* L. P. Blum, A. G. Butler, W. N. Dambach, J. L. deVou, C. F. Goodrich, J. P. Growdon, J. P. Leaf, M. G. Mansfield, G. E. Poucher, John M. Rice, L. J. Riegler, R. L. Templin, W. F. Trimble, Jr. Marshall Williams.

Men's Golf and Sport Committee: A. C. Clarke, *Chairman;* J. D. Beatty, J. T. Campbell, C. E. Long, G. E. Poucher.

City Planning Program Committee: John M. Rice, *Chairman;* U. N. Arthur, Frank P. Best, Frederick Bigger, Edward Schmidt, Charles M. Reppert, Park H. Martin.

Sanitary Engineering Program Committee: George E. Barnes, *Chairman;* George B. Gascoigne, George B. Sowers, Rollin F. MacDowell.

Highway Program Committee: R. R. Litehiser, *Chairman;* William E. Burroughs.

Ladies' Committee

Mrs. Morris Knowles, *Chairman*
Mrs. E. N. Hunting, *Vice-Chairman*

Mrs. C. G. Dunnells
Mrs. F. J. Evans
Mrs. R. P. Forsberg
Mrs. J. P. Growdon
Mrs. N. B. Jacobs
Mrs. A. V. Karpov
Mrs. J. C. Kohl
Mrs. J. F. Laboon
Mrs. J. F. Leonard
Mrs. L. C. McCandliss
Mrs. F. M. McCullough
Mrs. L. W. McIntyre
Mrs. C. M. Reppert
Mrs. J. M. Rice
Mrs. J. W. Rickey
Mrs. N. Schein
Mrs. C. B. Stanton
Mrs. R. L. Templin
Mrs. H. A. Thomas
Mrs. W. F. Trimble, Jr.

The program as a whole has been prepared under the direction of the Northern Region Meetings Committee, Henry E. Riggs, *Vice-President, Am. Soc. C.E., Chairman;* and F. A. Barbour, Charles B. Burdick, James L. Ferebee, H. S. Morse, C. E. Myers, C. Arthur Poole, T. J. Wilkerson, *Directors, Am. Soc. C.E.*

Please call on the Committee on Local Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Professional Activities of the Society

Abstracts of Addresses on This Subject at the Portland Convention

As a part of the Portland Convention, a symposium was held on July 15, 1936, at which were described some of the more outstanding ways in which the Society is of service to its individual members professionally. Eight addresses were delivered, dealing respectively with salaries of engineers, engineering fees, reemployment of engineers, registration of engineers, professional development, national relations, education of the public, and aims and activities of the Society. Abstracts of these addresses, in as complete a form as space will permit, are here presented for the information of members.

Salaries for Engineers

By Ernest P. Goodrich, M. Am. Soc. C.E.
Consulting Engineer, New York, N.Y.; Chairman of the Society's Committee on Salaries

The Society's present Committee on Salaries has been in existence since 1929. Except during the period of acute depression, when its activities were diverted temporarily along the lines of job creation and personnel placement, the committee has been primarily concerned with the collection of salary data and other fact finding. Naturally, its first activities included a study of the work done by previous committees, both within and without the Society, and a compilation of the then existing salary statistics and related information. The collecting of such data has been and must be a continuing activity. To date the committee has probably sent out in excess of 30,000 inquiries; the work for 1935 alone aggregated some 3,500 letters and telegrams.

Ernest P. Goodrich

It has been the practice of the committee to secure and maintain an up-to-date reservoir of facts on the basis of which information can be supplied to the Society's secretariat to enable it to answer the large number of individual requests that have been made for assistance in connection with the solution of salary problems. Incidental to this work, the office of the Secretary has developed a technique which can always be applied by local groups desiring to educate budget officers and others in regard to the value of engineers to the community and the compensation they should receive for their services. The detailed data for use in connection with such activities, have been drawn from the files of the Committee on Salaries.

In October of 1931 the Society first took official cognizance of the unemployment that was likely to afflict the civil engineering profession and set new activities in motion to stem the tide of salary reduction and to seek sources of reemployment for civil engineers. That month the then President of the Society, Francis Lee Stuart, the Secretary, and I called upon President Hoover to suggest that by executive order he inaugurate an immediate expansion of the mapping of the United States. Our appeal, by the way, was without result.

There is ample evidence that on October 31, 1932, 35 per cent of the civil engineers of the country were out of employment. No survey has been made to determine how many are unemployed today or are engaged in other than civil engineering work. Evidence from many sources, however, indicates that to a very considerable extent—possibly to the number of 30,000—civil engineers are reemployed, as that word is to be understood in differentiation from unemployed. It is true that much of the reemployment is on work carried on by agencies of the federal government, the character of which is temporary, and that the conditions of this reemployment, particularly with respect to salaries, are not equal to those of normal times.

That the Society has done much to facilitate reemployment is unquestionably true, and that it has done much to improve conditions of employment is equally true. The salaries to be paid engineers in many of the newer federal activities have been a matter of great concern to the Board of Direction and the Society's other officials, and in this direction the Committee on Salaries has been constantly active. First, its attention was directed to comprehensive surveys of existing employment and salary conditions among civil engineers. Later it devoted itself to setting forth the data thus accumulated, in an effort to stem the tide of salary reductions, and still later, to provide a guide to the establishment of fair salaries for engineers employed under the FERA.

In anticipation of salary cuts by tax-conscious communities, in the fall of 1930 a questionnaire was sent to the 15,000 members of the Society, and a questionnaire of different type to 5,000 additional persons comprising the heads of state engineering departments, city and county engineers, and railway and utility executives.

The Committee on Salaries made a further survey during the winter of 1932–1933 to determine the progress of unemployment among civil engineers. This survey also furnished information on the effect of the depression on the practice of consulting engineers and their employees.

In the spring of 1934, the committee prepared a report on "Prevailing Salaries of Civil Engineers," based on a survey of the salaries paid to some 16,000 engineers and engineering assistants in the highway departments of the 48 states in 1930 and early 1934. The data were secured from the Local Sections of the Society, and from other sources. This report was prepared at the specific request of officials of the Civil Works Administration. It was to be used to establish rates of pay for technical men on emergency work programs.

The Committee on Salaries has answered several specific inquiries as to the adequacy of local engineering salaries, and in each case has supplied data showing the relation of such salaries to those obtaining under similar conditions in other parts of the country. During the year 1935, for example, specific replies were made to inquiries as to the proper salaries for engineers in the following categories: city engineer, executive engineer on very large project, state highway bridge engineering division, lower grades (for Federal Resettlement Administration), complete engineering organization for a small city, complete engineering organization for a small state, a private holding company, and a large subway engineer group.

In addition to its activities along the foregoing lines, the committee has constantly maintained as one ultimate aim, the formulation of a comprehensive classification of engineering positions, together with the appropriate salaries therefor. The further the committee proceeds in this direction, however, the more complex the problem becomes. Size and type of organization, geographical location, magnitude of work, individual responsibility, local social environment, local cost of living and living level, increasing cost of professional preparation, civil service control, and perhaps a score of other factors, introduce a corresponding number of variables into the salary equation. The formulation of a desirable classification of positions and a salary schedule for any individual organization at any given time and place is time-consuming and somewhat intricate. Such a schedule must be justifiable in the eyes of local officials and the general public, must be able to bear comparison with existing schedules for other similar groups, and must not prevent the engineering organization in question from competing successfully with other engineering and social organizations. This statement is as far as the committee feels justified in going at the present time. It is its unanimous conclusion that none of the systems so far devised is adequate for universal application. It proposes to continue its activities in this direction, with the approval of the Board of Direction, in the hope of ultimately submitting the best possible comprehensive scheme and formula for determining appropriate salaries in practically all types of organizations, under the widest variety of conditions.

The committee has endeavored constantly to be on the alert to serve the membership in every possible way within its power and jurisdiction. Its members have contributed generously of their time and experience, and feel that they have been successful in at least some small degree in enhancing the position of the engineer in the community.

Engineering Fees

By ENOCH R. NEEDLES, M. AM. SOC. C.E.

CONSULTING ENGINEER, ASH-HOWARD-NEEDLES AND TAMMEN, NEW YORK, N.Y.; CHAIRMAN OF THE SOCIETY'S COMMITTEE ON FEES

THE engineering profession is concerned mainly with the more exact sciences. By education, training, experience, and temperament the engineer is prompted to think from facts and reach true and definite conclusions. Probably the thing that troubles him most in the practice of the profession is the matter of compensation—how to be profitably and well employed.

ENOCH R. NEEDLES

There is no exact science to help the engineer solve this problem. He must resort to psychology, economics, and philosophy for aid—psychology to assist him in gaining a new client or employer; economics, to enable him to determine a reasonable relation between engineering fees and salaries and the millions of dollars in design and construction for which he may be responsible; and philosophy, to bolster his optimism between engagements, and to console him with the knowledge that he possesses great potential values and true abilities even when his talents are least actively employed.

All engineers are interested in adequate fees and salaries. They cannot have adequate salaries without adequate fees, nor can they expect adequate fees if adequate salaries are not the accepted practice. It is probable that almost nine out of ten civil engineers are salaried men, with large numbers serving public bodies; but still the matter of fees is of consequence to the entire profession. This is true, just as it is to be recognized that the Society's Code of Ethics and the maintenance of high professional standards are of great significance to all engineers.

In considering fees and other professional matters, the engineer frequently makes comparisons between his profession and that of law, medicine, or architecture. These comparisons may mislead him if he does not recognize some of the differences between the professions. Lawyers operate largely as individuals, identified with private offices dependent upon fees; relatively few are in public employ. Doctors are even more largely individualists, serving in private offices. Even among architects few men are in public employ; most of them serve in private offices, and most receive fees, or salaries that are dependent on fees.

There are very close and fundamental ties between all architectural undertakings, in form and in practices. Primarily, architects deal with buildings. Civil engineers, on the other hand, find themselves in a broad field—so broad that every type of construction is encompassed; and each type is so distinctive that it becomes a field of its own, with special practices and techniques so exacting that engineers as individuals must attain specialized experience if they are to serve properly.

Each of these branches of civil engineering carries its own standards and practices in regard to service and compensation. In addition, different sections of the country will find different standards regarding compensation within the same special field. Then there are the different degrees in which an engineer may serve—all the way from occasional advisory service up to complete engineering service, which includes field surveys, preliminary studies, special reports, final plans and specifications, testing of materials, and supervision of construction.

Engineers may well agree that the subject of engineering fees is complex. We are not selling commodities. We are providing personal services. We have many intangibles to cope with, and still we must know business methods. We must be able to estimate salary costs closely. We must know the cost of being in business with an organization ready to serve, whether we have many clients or none. We must arrange to live between engagements. We will not remain in business long if we do not consider our overhead and other indirect costs.

Architects have printed forms, furnished by the American Institute of Architects, for use in correspondence with prospective clients. These forms name the standard fees and terms of engagement. Just what the Society can do in this direction is not yet clear. Surely all of us desire a simple and direct means of naming an adequate fee which will be authoritative. The best we can look forward to now is the development of several schedules of standard fees, one for each of the several principal branches of civil engineering. Water works engineers may develop one schedule of standard fees, sanitary engineers another, bridge engineers another, and so on, but these schedules may require adjustment to meet conditions in various parts of the country.

Last year the Society's Committee on Fees developed its report, "Recommendations for Determining Fees to Be Allowed for Professional Engineering Services on Federal and Federal-Aid Projects." These recommendations, developed from *Manuals of Engineering Practice* Nos. 5 and 6, were approved by the Board of Direction and have been distributed to the membership in printed form. This action was taken at the request of Past-President Tuttle in order that officials of the federal government might have the simplest possible means of passing upon the

FALL MEETING of the Society, October 13–16, 1936, at Pittsburgh, Pa.

appropriateness of engineering fees. The acceptance of the committee's recommendations by the federal PWA authorities has been most gratifying, and there is much evidence that engineering fees on PWA work have since been put on a sounder basis. A number of engineers have found this pamphlet very helpful in discussing fees with prospective clients.

The adequacy of an engineering fee may be judged much as is the fair market value of real estate. The courts have held that the fair market value of land is best determined through having a free seller—one who knows values, and who does not have to sell but is agreeable to selling—and a free buyer—one who is informed as to values, is willing and can afford to pay a fair price, but is not forced to purchase. A meeting of minds between a free seller and a free buyer should establish a fair market value. We as engineers may well fix our fees in the spirit of free sellers of land, and we may pray for more clients educated to act in the spirit of free buyers of land.

Engineers themselves require about as much education on this subject of adequate fees as do some of their clients. I have read a number of times our *Manuals of Engineering Practice,* Nos. 5 and 6. Each time I read them I marvel at the wisdom, breadth of experience, soundness of judgment, and advice revealed in those few pages. I commend them to all engineers for frequent reading; and may they strive to follow the principles set forth therein.

Engineers can charge to themselves a great many of the abuses in regard to fees, and probably also in regard to salaries. We know that there are many instances of exceedingly low per diem rates of payment for the services of consulting engineers of distinction on government projects. The consultants serve because they may not be engaged otherwise and because of the compelling desire to render service, which comes before any thought of compensation. The sad thing is that these very low per diem rates are fixed, or are permitted to be maintained, by or through engineer officials.

We know of invitations or requirements for submitting proposals for rendering engineering services which are nothing more than bidding propositions, and which result in the work being given to the low bidders. These conditions are established by engineers themselves, high ranking engineer officers of corporations and public bodies. These competitions are frequently more unprofessional and more coldly mercenary than other competitions conducted by non-engineer public officers. Possibly it is easier for an engineer to become a free seller than it is for him to function as a free buyer. The unhealthy phases of pure bidding competitions for engineering services need not be outlined to thinking engineers.

In the past there has been considerable discussion concerning the furnishing of engineering services on a fee basis by engineers who are employed otherwise on a salary. It has been claimed that such salaried men are prompted to ask fees substantially lower than an engineer in private practice could afford to name. There are many other matters of greater importance to our profession. None can deny that practical experience for engineer professors is most healthful and desirable, or that many of our ablest engineers are professors whose engineering ability should not be restricted in public service.

An excellent answer to this problem appears to lie in the present practice of one of our foremost universities. Any member of the faculty who wishes to be in line for promotion must agree to pay to the university treasury half of every fee he receives for services rendered outside. That part of the fee which goes to the university may be likened to the similar charge which the engineer in private practice must make to care for overhead and indirect costs. This arrangement might well be adopted by all engineering institutions.

Not many years ago, an engineer officer asked me how adequate engineering fees could be established and how a consultant could be selected appropriately without competitive bidding. The procedure is simple and wholly professional. Let the official invite three or four qualified consulting engineers to discuss with him individually the general character and extent of the work and the fee that reasonably should be paid. Then let the official finally decide what fee shall be paid and what the services shall be, and select his engineer as he would his personal physician, taking into account any reasonable factors—such as location, reputation, special fitness, capacity to serve, previous acquaintance, and enthusiasm for the job—that will lead to complete confidence that the right engineer is being employed. The one qualification to this procedure is that no government officer should favor one engineer alone when it is possible to distribute the favors.

I may be considered an idealist, and I think most engineers are, but I believe that the payment of adequate fees by clients is largely in the hands of engineers themselves. I am not thinking now of licensing, greater publicity for engineers and their projects, greater participation in public affairs by engineers, stronger organizations among engineers, or standard salary or fee schedules, although each of these has a place. I am thinking of first principles which engineers must not forget. It may be old fashioned, but I believe it is healthy to remember occasionally one of the old copy-book maxims, "Quality is remembered long after price is forgotten." If we strive to inspire our clients with complete faith and confidence in us as men educated and trained to do our jobs; as men of complete loyalty and integrity; as men devoted to our trust; as men with judgment, understanding, vision, and optimism; as men worthy of warm personal friendships; as men of industry, with complete enthusiasm for our labors; and finally, as men to whom our profession becomes a religion through which we serve our fellow men, we shall not lack for adequate fees.

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Engineering Reemployment

By GEORGE T. SEABURY, M. AM. SOC. C.E.

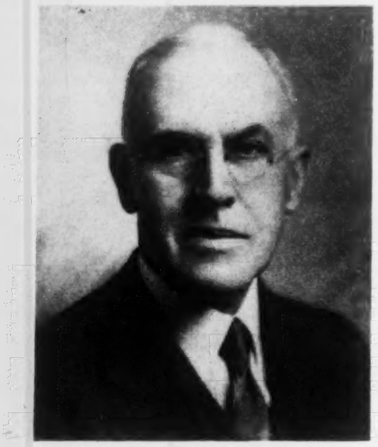
SECRETARY OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, NEW YORK, N.Y.

STRANGE as it may seem, although there were definite signs that unemployment among engineers was imminent as far back as July 1928, such signs were not recognized. A study of the details of "placements" made by the Engineering Societies Employment Service offices in New York, Chicago, and San Francisco, shows the approach of unemployment—first in New York in July 1928, then in Chicago in April 1929. It was only at the moment of the stock-market crash in the fall of 1929, however, that this condition became evident at the San Francisco office, indicating a lag of 17 months in crossing the continent.

Unemployment began first with electrical engineers, and continued with the mechanical engineering branch of the profession. Strangely enough, it is well authenticated through surveys made by the Society's Committee on Salaries, that the peak of all-time employment and of all-time salaries for civil engineers was deferred until the end of 1930, although civil engineers experienced some acceleration of dismissal and reemployment prior to that time. From that date until October 1932, unemployment among civil engineers increased at a much accelerated pace. In that interval of one year and 9 months, the surveys show approximately 35,000 civil engineers lost their positions, and the salaries of many others were greatly reduced. In the meantime, moreover, civil consulting engineers and engineers in the private practice of civil engineering saw their businesses progressively shrink until it is safe to estimate that not more than 30 per cent of the volume in normal times remained.

Since 1918 the Employment Service has been operated as a joint enterprise of the four national (Founder) engineering societies. In normal times it is self-supporting, but during the depression it has been necessary for the Societies to subsidize the operations of the Service.

Inasmuch as the Employment Service deals only with regular engineering positions, its operations constitute a sort of barometer of the engineering employment situation. For example, while employment operations reached the low point in October 1932, they have now returned practically to the 1929 level. In that interval more than 2,500 men have been placed by the Service in regular work. This figure, which excludes all emergency positions, furnishes evidence of the present growing demand for engineers.


GEORGE T. SEABURY

In October 1931, the Board of Direction first took official cognizance of what was to happen to the civil engineering profession in the way of unemployment. At the suggestion of the Society's Committee on Salaries, the Board called upon the Local Sections at that time to organize committees to survey the local conditions of unemployment among civil engineers and to devise ways and means for their reemployment and for their immediate financial support.

The first organization to be thus formed was developed by the New York Metropolitan Section, under the leadership of George L. Lucas, then president of that Section. It was known as the Professional Engineers' Committee on Unemployment (P.E.C.U.). P.E.C.U., which is still functioning, has placed in various positions to date, 2,935 members of the four Founder Societies of civil, mining, mechanical, and electrical engineers, and 6,740 engineers who were not members of any of these societies. In this connection it may be noted that the members of the four Founder Societies have supported P.E.C.U. financially to the extent of more than $208,000.

P.E.C.U. has thus placed in temporary or permanent positions, 9,675 engineers resident in the New York metropolitan area. It has been the most successful of all such reemployment committees established throughout the country by the Society's Local Sections. However, very good results have been obtained by similar organizations in Philadelphia and in Boston, where reemployment problems were particularly acute. While it is impossible to estimate the money value of positions received through these volunteer organizations, the most conservative estimates indicate that such positions must have returned to members of the profession many millions of dollars.

It is, however, upon the efforts made by the Board of Direction of the Society, its officers, and its committees, that interest will center. Early in 1932, when the investment bankers had resolved, in convention, to make no more municipal loans, a group of 16 members of the Society proposed the extension of federal credit to state, county, and municipal units to assist them to continue their useful and worth-while public works construction. This was proposed primarily as a measure to revive industry and increase general employment.

The Executive Committee and the Board of Direction of the Society approved the idea, passing a resolution favoring acceptance of the principle by the Congress of the United States. A Committee on Public Works was appointed. At the request of President Hoover, this committee made a survey, with the aid of the Local Sections of the Society, to determine the amount and kind of worth-while public works throughout the country that had been deferred because of the banking conditions then prevailing. As the data accumulated, these reports, in the form of 28 memoranda, were transmitted weekly to the President of the United States.

Unquestionably the factual information thus developed contributed largely to the passage of the Emergency Relief Act of 1932. Incidentally, this Act made possible the employment of several thousands of engineers, directly or indirectly, through public works construction financed by the Reconstruction Finance Corporation. Subsequently the principle found acceptance in more liberal terms under the National Industrial Recovery Act of 1933. Through the agency of the Public Works Administration, this Act undoubtedly provided employment, directly and indirectly, for further thousands of engineers on various projects throughout the country.

In the organization of the Public Works Administration, it is particularly gratifying that a procedure which has been carried on by the Society for many years was found very helpful. As the work of PWA called essentially for civil engineers, it was to the Society that the PWA officials came in the early days for selection of personnel. The Society's file of thousands of biographical and professional records was placed at their disposal. The files were examined and, upon request, hundreds of records were copied and forwarded. In *Back to Work*, Administrator Ickes acknowledges the assistance thus rendered in the following sentence: "Lists of names of men equipped to act as state engineers were supplied by the American Society of Civil Engineers . . . ."

It may be added that this file has been a source of reference used successively by administrators of CWA, FERA, WPA, TVA, the Coast and Geodetic Survey, the National Park Service, and many other federal agencies both permanent and temporary. The reputation of the Society and its members is such that federal officials have become accustomed to utilizing this reservoir of information. Also, many members use the Society as a reference for verification of their qualifications or experience as reported.

For many years, the Board of Direction has supported a move to accelerate the geodetic control network and the topographic surveys of the country. Although this objective has never been achieved as a matter of governmental policy, certain operations have been expanded. Most of the funds expended on such work consist of engineers' salaries, and the program has the further merit that the results obtained are immediately usable by the general public and by the various federal agencies.

Efforts to inaugurate an expanded mapping program resulted in the inclusion in the Emergency Relief Act of 1932 of $1,250,000 for the work of the U. S. Coast and Geodetic Survey. This permitted an enlargement of the field forces, the establishment of computing offices for making the calculations incidental to an expanded field force, and an expansion of the aerial mapping of coastal waters along the Atlantic seaboard. In the fall of 1933 more than 10,300 men, chiefly engineers, were engaged throughout the country on these local control surveys.

The whole program was thrown into confusion, however, by the Act of Congress prohibiting participation by federal bureaus in Civil Works Administration operations, and permitting the work

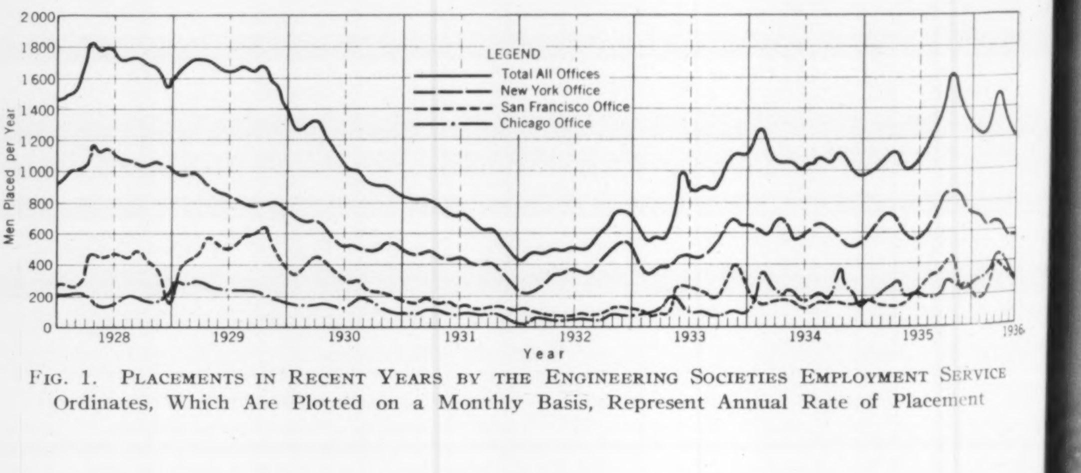


FIG. 1. PLACEMENTS IN RECENT YEARS BY THE ENGINEERING SOCIETIES EMPLOYMENT SERVICE
Ordinates, Which Are Plotted on a Monthly Basis, Represent Annual Rate of Placement

of each local project to continue only after approval by the state concerned. That only four states failed to provide continuation is evidence of the general approval of this survey program. State supervisors, appointed at the inception of the project, continued in charge of the work in most states, but could act only in advisory capacities.

At the close of 1934, while some work was under way in each of 23 states, the staff had been reduced to approximately 3,000 men. At the close of the fiscal year 1935, it became necessary for the Coast and Geodetic Survey to discharge an additional 2,400 men who had been thus employed in various parts of the country.

When the federal program of reforestation was inaugurated, the Secretary of the Society, acting under instructions from the Board of Direction, urged the administrator to use trained engineers in the design and construction of roads, bridges, water supplies, and such, as well as on the surveys of those areas the government contemplated acquiring for reforestation purposes. This program, as well as that of the National Park Service, engaged the services of large numbers of civil engineers, including many recent graduates who would otherwise have found it difficult or impossible to obtain positions at that time.

A situation developed wherein the Society could be of help with respect to the operations of the Home Owners' Loan Corporation. Complaints were received from members that payments for lot surveys were being refused on the ground that applications for the loans had been declined. The Local Sections of the Society were asked to report all such incidents in order to determine the extent to which this practice prevailed, and Society officers took immediate steps with the corporation to bring about a prompt change of policy and to obtain reimbursement in those cases reported.

A great deal of engineering work was necessary in preparing the designs and plans required in connection with applications for credit from the Reconstruction Finance Corporation and the Public Works Administration. In some instances, plans were prepared by municipal engineering organizations and in other cases by engineering firms in private practice, engaged for the specific jobs in question. The presidents of the Society and others of its officers conferred frequently with federal officials respecting the details of these procedures and the rectification and modification of the regulations, and as a result certain corrective measures were brought about. Effort was made also by American Engineering Council with the supervising architect of the Treasury Department to utilize the services of engineers in private practice and their regular assistants for the design and construction of buildings under that department.

American Engineering Council is an organization which represents 42 national, state, and local engineering societies. One of its recent activities is an employment survey which has been completed and is now being compiled by the U. S. Bureau of Labor Statistics. In this survey a spot census was made of some 175,000 engineers of all classes, throughout the United States. The survey is intended to determine many questions regarding employment, and it is hoped some of the findings will disclose new avenues that will lead to the wider employment of engineers. The Society collaborated extensively in the development of this survey.

Owing to the quiet methods used, the profession and even the members of the Society are to a large extent unaware of the attention which the Board of Direction, the presidents, and other officers of the Society have paid to the many problems which have arisen in these past five years. Resolutions have been few. Public announcements of this or that proposed objective have been few, and the recounting of successes have been few. This is because it was believed that more could be attained through helpful suggestion and friendly conference with those charged with official responsibility than by dramatics or denunciations.

The profession is indebted to the administrators of federal and local agencies for the courtesy, patience, and sympathetic consideration given its emissaries.

Registration of Engineers

By JAMES L. FEREBEE, M. AM. SOC. C.E.

CHIEF ENGINEER, MILWAUKEE SEWERAGE COMMISSION, MILWAUKEE, WIS.; CHAIRMAN OF THE SOCIETY'S COMMITTEE ON REGISTRATION OF ENGINEERS

MANY members may not realize that the subject of engineering registration has been considered by the Society at least intermittently for the past thirty-five years, the first effort being an informal discussion by ten members in the year 1901. Although the Board of Direction did not officially endorse the principle of registration until 1931, the Society and its members did much in the intervening years to keep alive the spark of enthusiasm for such legislation. In 1910 a committee of the Society prepared the first so-called model registration law. It was revised from time to time and in its present form was officially adopted by the Board in 1932. The present model and its predecessors have been substantially the groundwork of most existing registration legislation.

JAMES L. FEREBEE

Thirty-six states now have such laws. In the past three or four years there has been a decided quickening of interest in the other Founder Societies, and it would seem that the remaining 12 states might be added to the list with less difficulty. But if it takes a dozen years to get them all, it is still worth the effort.

Existing registration laws have been procured by groups of engineers who have interested themselves enough in the political situation of the state to have laws enacted, and it has not been an easy battle. I think all of us who have gone through it have had experiences similar to those of the Connecticut group. In that state the law was first vigorously advocated in 1921, if I recall correctly, but was not finally passed until 1935.

If laws are to be enacted in the remaining states, it is highly necessary for the members of the Society resident in those states to get busy. They have the groundwork as furnished by the Society; they have the interest of this Society through its Committee on Registration; and they have the interest of the National Council of State Boards of Engineering Examiners, and such help as it can give. The Society's only apparent instrument to assist and to foster registration is its Committee on Registration. As chairman of this committee, I must admit that it cannot accomplish very much. We have no facilities—no right, perhaps—to go into a state and foster the passage of a law unless the engineers resident in the state are fully back of the proposal. We are represented, of course, through the agencies of the Local Sections, whose interests are to foster such laws and, having secured them, to see that substantial compliance with their terms is obtained.

It is my personal opinion that the Society could well afford to lend assistance—financial assistance—to the National Council of State Boards of Engineering Examiners, as it does today to American Engineering Council and many other coordinate agencies. The National Council has almost a legal standing, particularly as its members are the legally constituted representatives of registration in the states that now have laws on the subject. I have suggested such action, and it will be my endeavor to continue to urge the Society to contribute some substantial sum which will enable the National Council to take the position it should take in completing registration, in coordinating the laws to make for more uniformity, and in seeking compliance with them.

Legislatures will convene next year, I believe, beginning in January, in 10 of the 12 states that still have no registration laws. It is not now too early for all engineers—not civil engineers alone—within these states to decide among themselves whether they want such a law. If they decide that they do, then they must conduct a very definite and intelligent educational campaign among the representatives of the people. They will find that many persons have little interest in the engineer because they do not know what he is; they confuse him with a number of non-professional groups carrying the designation of engineer. These persons must first be brought to look upon the engineer as they look upon the lawyer and the doctor; only then will they understand clearly what the engineers are trying to get at. The registration of engineers is running in strong competition with the registration of artisans, which many legislators oppose. The distinction must be made clear and the opposition must be broken down, if we are to succeed.

The Society, through its Committee on Registration, through the registration committees of its Local Sections, and through the National Council, will aid in all possible ways in securing favorable action next year upon such laws as may be desired.

Professional Development

By C. F. HIRSHFELD

CHIEF OF RESEARCH, THE DETROIT EDISON COMPANY, DETROIT, MICH.; FORMER CHAIRMAN OF THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

THE recent World War and the social and economic disturbances that preceded and followed it have served to make humanity more introspective than is usually the case. There has been a wholesale questioning of aims and objectives, wide speculation over the virtue of existing forms of government, of social organizations, and of economic principles and methods. Coincident with and incidental to the phenomenon of this general mental upheaval has come a dawning sense of the tremendous influence of the engineer and his works in the modern world.

C. F. HIRSHFELD

To some engineers and to some others it appears that insufficient study has been given this phase of current thought. It appears as though many leaders of public opinion have acted upon superficial appearances rather than upon deep and careful study. There seems to be no doubt that the scientist and the engineer have more or less unwittingly changed the complexion of the civilized world so that we now face an economy of plenty instead of, as in all the human past, an economy of scarcity.

One who is reasonably well acquainted with the human animal and his history realizes that the real significances of a change of such magnitude cannot be grasped and appreciated instantly. The human animal observes certain isolated phenomena first; it is only after deep study and long thought that he generalizes from the isolated observations. Therefore, it is not surprising that in the rather sudden transition from the economy of scarcity, to which he has been accustomed through untold ages, to the near realization of an economy of plenty he should balk at the unknown, should condemn the very things that are to improve his life. Indeed, it is not at all surprising that many of the political leaders of the world should be directing their efforts towards the artificial production of scarcity in the fond hope that by so doing they can return the human family to conditions under which it has been accustomed to live, and which it understands.

One would expect, or at least hope, that the scientists and engineers who have produced this drastic change in the limitations of human existence would comprehend the significance of their works, come forward to the defense of these works and their results, and assist in the formulation of those changes in viewpoints, laws, and practices necessary to life under the new conditions. A few outstanding and exceptional individuals have attempted to do so. But they have been literally crying in the wilderness. Their brother scientists and engineers have either run with the pack or sulked on the side lines. The pack itself has been too busily engaged in following accustomed leaders to pay any attention to these few understanding individuals. One might observe that humanity to this day would rather give credence to the mumbo-jumbo of the medicine man than listen to a leader who goes about unadorned with feathers, shells, and claws, and who speaks in terms of natural forces, rather than in terms of spooks, spirits, hobgoblins, devils, political fetishes, and what not.

It is somewhat understandable that the average scientist should have ignored the consequences of his works. He is in many respects a mental recluse. He is concerned with the doings of nature rather than with the doings of human beings. He is bent upon the uncovering of knowledge rather than upon its practical application.

But what is one to say about the engineer in this regard? He is supposed to be a factual thinker. It is supposed to be his function to apply the work of the scientist to the service of humanity. He is supposed to be the individual who by such applications ameliorates the conditions of human life. How does it happen that he, when accused of having turned the world upside down and of having brought on a disease that requires major operations for its cure, should not only stand idly by but should actually agree that perhaps his works are not the wonderful gift to humanity that he thought them?

I think the answer lies in the way in which we engineers have been educated, have worked, and have lived. We have been so convinced that what we did was good for our fellow men, we have been so wrapped up in the doing itself, in what one might call the technical perfection of the job, that we have not had the inclination or taken the time to determine the significance and effect of the incidence of these works upon laws, customs, forms of government, and even processes of thought inherited from long-past generations.

I think we should have started years ago to prepare ourselves to interpret our works and their significance. I think we should have realized that we were introducing them into a world which was not socially, economically, or politically prepared for them. I think we should have been preparing ourselves to assist the conventional leaders in obtaining more or less rational solutions to the social and economic problems we, at bottom, have been responsible for creating. Instead, with a few marked exceptions, we have thrown up our hands; we have left to lawyers, economists, and professional politicians, completely ignorant of the principles of engineering works, the solutions of the problems we have created.

It would seem to be high time that we as engineers did something about all this. If we believe our works good for humanity, if we believe it possible safely to produce an economy of plenty instead of one of scarcity, if we have faith in ourselves and in our works, then let us prepare ourselves as quickly as possible to do our share in preventing old customs, methods, and viewpoints from retarding the arrival of the better day we can envision!

I like to regard the formation of the Engineers' Council for Professional Development as one of our first moves in this direction. Its purpose is expressed as the coordination and promotion of efforts and aspirations directed towards higher professional standards of education and practice, greater solidarity of the profession, and greater effectiveness in dealing with technical, social, and economic problems. I call your attention particularly to the last

FALL MEETING of the Society, October 13-16, 1936, at Pittsburgh, Pa.

ten words. This expression of purpose removes this movement from the rather narrow personal and professional aggrandizing effort that some have assumed it to be. Note the avowed purpose of bringing about a situation in which the engineer will be more effective in dealing not only with technical but also with social and economic problems.

Unfortunately, we as a profession are hardly ready to accept as yet a proper share of such a burden. We must first educate ourselves as thoroughly in these new fields that our works are carrying us into, as we have educated ourselves in the technical fields. We must acquire not only a facility in what recently has been christened "humanics," but also the ability to deal with our fellow men in ways to which we have not yet accustomed ourselves. In technical engineering matters we have not often had to educate or persuade people in other walks of life. We have been hired as technical experts to do technical jobs. Faith was reposed in us, and to our credit be it said, we have had comparatively few technical failures. Now, however, we enter upon a new form of life. We remain responsible as before for the technical accomplishments, but we also take on the rather difficult task of cooperating with many other branches of the human family in an effort to warp inherited forms to new ones capable of utilizing our technical developments to the best advantage.

To me this explains the fact that, starting with a clean slate and no preconceived ideas, the Engineers' Council for Professional Development has thus far found it desirable to concentrate largely upon what may be called educational aspects, interpreting these words in a very broad sense. The individuals who brought the Council from a thought in the human brain to a living, functioning entity naturally felt their way as they proceeded. I think it very significant that under such circumstances they should have concentrated on broad educational lines to the extent they have.

As one who has given long and careful thought to the place of the engineer in our modern civilization I bespeak your wholehearted support for the Engineers' Council for Professional Development as well as for all other proper efforts towards broadening the outlook and life of the engineer. This plea is not made for the sake of the engineer but for the sake of civilized humanity. We, the engineers, who have learned how to produce for humanity an easier, a fuller, and I hope, a better life, must now fit ourselves to assist humanity in availing itself thereof and profiting therefrom.

We need not worry about the recognition of engineering as a profession and of the engineer as a professional man. Such recognition will come just so soon as we engineers make ourselves worthy of it. And to be worthy of it I am satisfied we must step out of our narrow technical ways to the extent necessary to fill a much larger place in the scheme of human life and human effort. We must remain the accomplished technicians we now are but we must acquire knowledge and skill in other very different fields as well. We must learn not only to use our peculiar processes of thought in non-technical fields, but we must learn also to sell to others the products of such thinking.

National Relations

By ALONZO J. HAMMOND, PAST-PRESIDENT AM. SOC. C.E.

CONSULTING ENGINEER, CHICAGO, ILL.; A REPRESENTATIVE OF THE SOCIETY ON AMERICAN ENGINEERING COUNCIL AND THE CONSTRUCTION LEAGUE OF THE UNITED STATES

Under the heading of "national relations" the functioning of the Society may be considered under two categories—the actions of the Society per se and its actions through outside related channels such as American Engineering Council and the Construction League of the United States.

ALONZO J. HAMMOND

Although the Society was organized in 1852, it was not until 1929 that it began to function actively with regard to national affairs. In that year it became a member of American Engineering Council. It also adopted the report of its own Functional Expansion Committee, which stated that "the purpose of the functional expansion program is to promote the desirable functions of the Society to best serve the public and the membership." Of the four functions set up in this report, two are of especial interest here: "The promotion of engineering principles and the education of the public to the value of engineering in industrial and civil life," and "The elevation of the professional standing of the engineer."

In 1930, the professional department was set up. This department included, among other committees, one on public education, whose function was to "put into effect methods and procedures calculated to acquaint the general public with notable achievements in engineering; the advantages of applying engineering principles to industrial and civic problems; and the necessity of placing the administration of engineering matters in the hands of men of suitable qualification and experience."

The Society has been consistent in its support of these principles in national government affairs and has been helpful and fairly successful in accomplishing results of great benefit to the public welfare. It has participated in advocating the appointment of engineers as the active administrative heads of important federal agencies such as the Reclamation Service, the Public Works Administration, and the Tennessee Valley Authority, and it may confidently be said that the engineering administration has been well done, whatever may be one's viewpoint as to the social or economic aspects of the problems involved.

In 1933 the Society, as a member of the Construction League of the United States, participated in the preparation of the Basic Code of Fair Competition for the Construction Industry under the National Industrial Recovery Act. This led us into the formulation of a supplementary code for the engineering profession under the National Industrial Recovery Act. There was at the time a very vital question of whether, as members of a profession, we need become involved in a code, and every possible way of avoiding it was studied, discussed, and reviewed before we were forced into the issue. Fortunately perhaps for all of us, the Supreme Court acted before this code was approved.

The Society has participated directly in national problems, both through committees appointed by the Board of Direction, and in other ways. The Committee on Meteorological Data, for example, has worked with the Weather Bureau, and the Committee on Flood Protection has worked with the Geological Survey. The Society has representatives on the National Research Council and the American Standards Association. Special mention should be made of the assistance it gave in connection with the National Census of Engineers made by the Bureau of Labor Statistics. The preliminary work for this questionnaire, involving the classification and card-indexing of some 225,000 names, was done at Society Headquarters under the general direction of staff members. The first release of data from this survey, covering the educational background of the engineers reporting, was given out in June. [It appeared in the August 1936 issue of CIVIL ENGINEERING.] We are hopeful that the Bureau will shortly complete the analysis and give the rest of the results to the profession and the public.

The American Engineering Council was set up in 1920 at a meeting of delegates from 61 engineering organizations, with the stated purpose of furthering the public welfare "wherever technical and engineering knowledge and experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions." The preamble of the constitution of Council says: "Now, therefore, the engineering and allied technical societies of the United States of America through the formation of American Engineering Council realize a long-cherished ideal, a comprehensive organization dedicated to the service of the community, state, and nation."

As one of the principal national constituent members of Council, our Society therefore turns to it as a representative body to act in national public affairs, but there is in effect a very close association, so that our executive officers may and do collaborate in matters where such action is advisable.

The past two years American Engineering Council, under the leadership of J. F. Coleman, Past-President Am. Soc. C.E., has made great strides toward becoming a unit representative of and responsive to the entire engineering profession of the United States. It aims to keep in touch with all new national legislation which may affect the social, economic, and industrial trend of the nation and in any way concern the engineer. Its committee on public affairs delves in a non-partisan way into all the national problems which concern the engineer, and endeavors to aid the profession as a whole to exert its influence on national thought wherever the engineer's training may be of value.

A further effort will be made by Council to establish state and local public affairs committees to coordinate the action of the entire engineering profession; this will be done through contacts with the state and local engineering societies as well as with the sections of the national societies.

American Engineering Council is also concerned about the economic status of the engineer, the relation of the engineer in private practice to governmental agencies, the extension and protection of Civil Service, and about all other matters relating to the public welfare and the betterment of the engineering profession.

The Society, as I have previously mentioned, is also a member of the Construction League of the United States. This organization was set up to represent and to further the interests of the construction industry. It includes in its membership only national organizations representing engineers, architects, general contractors, special contractors, materials producers, and fabricators. The individual and firm memberships of the 17 national associations affiliated with it total well over 100,000. The Construction League affords a forum for ironing out the problems relating to all the elements of the industry as mentioned. It has been the means of providing a common meeting ground where the engineer and the architect come face to face and reach an amicable understanding on controversial questions. The engineer and the contractor, the engineer and the producer and fabricator, also study each other's points of view, all of which tends to create a harmony that is of advantage not only to the industry itself but to the public it serves.

As an example of the cooperation of these interests along national lines may be cited the Joint Committee of Engineers, Architects, and Contractors which called upon Admiral Peoples in 1934 to insist that the Treasury's public building program be so set up that architects could design the buildings in their own offices and that the work could be done by contract.

We have therefore in Washington two national organizations representing the two phases of the engineer's life—the professional by American Engineering Council and the industrial by the Construction League of the United States, both so set up and organized as to work in unison and accord for the best interests of the profession.

Mention should be made in this connection of another activity in which the Society is engaged—the work of the Engineers' Council for Professional Development. This is an organization of the four national engineering societies, known as the Founder Societies, plus the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners. Its object is to develop a program for the better introduction of the young engineer into the profession, and to render such service to the profession as will enhance it before the public, such as offering to the profession new fields of practice wherein engineers will be recognized as of high technical and cultural value to the public.

Education of the Public

By J. K. FINCH, M. AM. SOC. C.E.

RENWICK PROFESSOR OF CIVIL ENGINEERING, COLUMBIA UNIVERSITY, NEW YORK, N.Y.; MEMBER OF THE SOCIETY'S COMMITTEE ON PUBLIC EDUCATION

IT IS PROVIDED in the By-Laws of the Society that "The Committee on Public Education shall recommend, and upon approval shall put into effect, methods and procedures calculated to acquaint the general public with:

"(*a*) Notable achievements in engineering;

"(*b*) The advantages of applying engineering principles to civic and industrial problems; and

"(*c*) The necessity of placing the administration of engineering matters in the hands of men of suitable qualifications and experience.

"Such educational work shall be carried on at all times in a manner consistent with the dignity of the Society."

JAMES K. FINCH

The authority for this By-Law is found in part in the second of the four objectives of the Society as set forth in its Constitution, namely, that of professional improvement. It is very evident that the Committee on Public Education is thus charged with the responsibility of endeavoring to secure, through well-guided educational work of a dignified type, a better appreciation on the part of the general public of the part played by the engineer in modern life and a fuller understanding of the importance of engineering in the development of our economic and social order.

It will be noted from the preceding By-Law, however, that there is a second great objective set forth for this committee in the clause marked (*b*). I refer to the instruction that this committee shall endeavor to inform the public on the advantages of applying engineering methods in the solution of our pressing civic and industrial problems. This rests in part, I believe, on the first clause of the Constitution, which states that among the objects of the Society shall be "the advancement of the science of engineering"; and in part on a fundamental and basic attribute of professional life, as is implied in our use of the term "professional engineer," namely, that of public service. This is closely tied up with instruction (*c*) previously quoted, to the effect that well-qualified engineers are the best directors of engineering work.

To date this committee has confined its attention largely to the first of these two objectives—an attempt to direct public attention to the work of engineering and of engineers. The committee realized that it had a difficult problem before it and also that it would take many years of effort to counteract the effect of any false impression which might result from too precipitate action. It felt that in concentrating its initial efforts on this first objective, it would be working in safe territory and would be gaining experience on which to base further action.

Attempts to carry out even this policy during 1935 were not too encouraging. It was found that any effective results in this direction could only be secured through a sustained and directed effort—a type of activity which a committee could direct but could not effectively carry on. The Society was thus fortunate in securing, as manager of the publicity department, W. R. E. Baxter, who was formerly connected with the McGraw-Hill Publishing Company and is experienced in this work. Mr. Baxter's services began at the time of the Annual Meeting in New York in January 1936. His efforts are guided by the Committee on Public Education and are supervised by the Secretary of the Society.

At a special meeting of the committee, held in New York in March 1936, a detailed study was made of possible sources of information on engineering matters which might furnish data for articles for the public press. Such information not only concerns the various meetings of the Society—national, regional, and local—and items of public interest published by the Society in its PROCEEDINGS and in CIVIL ENGINEERING, but also special articles to be based on data secured from members who are connected with great engineering undertakings. We feel that it is important to give vital, human interest to such special articles through naming the engineers connected with them, and that at the same time the Society can thus bring home its efforts to its individual members.

Naturally the problem of securing publication for these more or less official Society releases is important. In our effort to develop news stories which will be truly educational and at the same time dignified and reliable, various possibilities have been studied, but we are relying primarily on Mr. Baxter's experience in this field, his ability to sense the "news value" of information, to put the data in proper form for release, and to select suitable publications.

The committee recognizes that the strength of a truly national organization rests largely on the effectiveness of local representation—on the development of strong and active Local Sections. Accordingly we have recommended that each Section of the Society appoint a publicity committee or designate a member of the local program committee as chairman of publicity.

In order to assist these Local Section representatives in securing better public notice for local and special meetings, Mr. Baxter has prepared a publicity manual, which has been sent to the presidents and secretaries of all Local Sections and to their publicity representatives. Needless to say, this manual is somewhat tentative in form and will probably require revisions and additions in the future. It is hoped in this way, however, and through conferences of the Society's Committee on Public Education and Mr. Baxter with local representatives, to develop a publicity movement which will be nationwide.

It is frequently said that engineers are too often inarticulate and that the profession is to be blamed, fully as much as the public, for the present lack of general knowledge of the work and methods of the engineer. We believe that these efforts should do much towards correcting this situation.

As a means of measuring, even in a very rough way, the progress which has been made in developing our "educational news agency," the following record is of interest:

MONTH, 1936	COLUMN INCHES PUBLISHED
February	975
March	1,262
April	1,907
Total	4,144

Assuming reasonable average advertising rates, this publicity would have cost an ordinary business firm at least $7,500.

We may thus summarize our progress to date by saying that we have developed the machinery for educating the public on the work of the engineer and that, for the past five months, this work has been going actively forward.

These news articles in themselves, by implication, aid in developing a consciousness on the part of the public of the value of engineering methods—of adequate fact-finding and analysis, of impartial study and intelligent, constructive action—in the solution of our modern civic and industrial problems. The committee, however, is studying ways and means of attacking this second objective more directly.

It is generally acknowledged, for example, that important measures for social and economic improvement have frequently developed in a more or less haphazard manner in the past, and that the gentlemen in black robes have been called in later to demonstrate that what has been done is wise and good. Such procedure is directly opposed to the engineering method, which seeks through intelligent direction, based on the analysis of known facts and the study of all available data, to solve economic as well as technical problems, in other words, to secure the desired result through design rather than by chance.

I believe that many of our members feel that, if the engineer can sell to the public this common-sense approach to pressing modern civil and industrial problems, he will have made a contribution to modern life which will transcend in importance even the almost magical material gifts, such as bridges, water supplies, and mechanical and electrical equipment, which he has made to modern civilization. We are at last beginning to realize that the older, hit-or-miss manner of "evolving" towards the solution of many basic problems of modern life is not only wasteful of time and money but too often involves untold suffering and the wrecking of many human lives. Until recent years the unparalleled resilience of American economic resources and a constantly expanding industrial life have absorbed, without undue strain, the useless and unnecessary losses due to economic and political blundering. It appears clear today, however, that this era has come to an end. The extent and limits of our natural resources are more clearly visioned, and new industries cannot be conjured up overnight to absorb unemployment. At best, the present measures for economic recovery can give us only relief, not security. Surely the time has come when we should approach these problems by the sane and sensible methods of the engineer, rather than through blind bias, emotionalism, and even worse, a short-sighted policy of narrow opportunism.

There are probably many engineers who see danger ahead if the Society should take an active part in social, economic, and political problems. If the committee had any such plans in view, this criticism would be just. We believe, however, that one of the basic attributes of professional life, particularly in a democracy, is expressed in the willingness of professional men to be of public service in any capacity that leads to the progress, happiness, and welfare of their fellow men. As engineers we hope this movement will result in advancing the standards of our profession. As citizens we believe that the nation will gain through the wider application of the methods of our profession to the problems of the modern world. We advocate no political, social, or economic doctrine. We simply insist that every problem be studied on its merits, that analysis follow fact-finding, and that action be based on such analysis.

It is to this problem—the problem of educating the American public to "the advantages of applying engineering principles to civic and industrial problems"—that the committee will next direct its attention.

Finally, all these efforts should aid in emphasizing the necessity of placing engineering matters in the hands of competent engineers rather than leaving them to incompetent laymen or political appointees. Our various local committees on professional relations have done much, particularly in connection with the PWA, the WPA, and the adjustments brought about in various state and municipal organizations through their activities, to protect and conserve the engineer's position as the man best qualified to direct engineering work. Inevitably the work of the Committee on Public Education will assist in strengthening and securing public support for this movement and also for the development of sound civil service and adequate tenure of office—elements essential to future planning and to the rational development of public works.

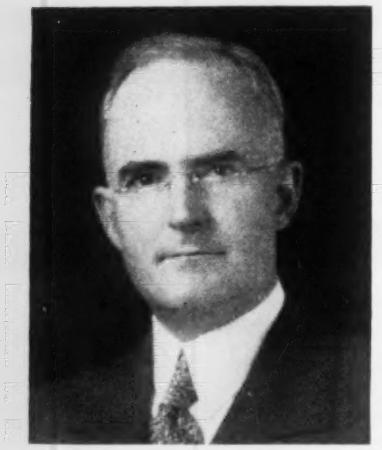
Aims and Activities

By J. P. H. PERRY, M. AM. SOC. C.E.

VICE-PRESIDENT, TURNER CONSTRUCTION COMPANY, NEW YORK, N.Y.; CHAIRMAN OF THE SOCIETY'S COMMITTEE ON AIMS AND ACTIVITIES

THE Committee on Aims and Activities was established by the Board of Direction at its meeting in Vancouver, in 1934. The committee appointed at that time made a final report at the Los Angeles meeting of the Board in July 1935, and urged the appointment of a permanent committee. The Board approved this recommendation. At the meeting of the Board in New York in January 1936, the committee's powers and permanency were reaffirmed.

The committee came into being as the result of a feeling on the part of the officers and Directors of the Society that the original Committee on Aims and Activities, which functioned so ably more than a decade ago, should be reestablished. A special committee, composed of Directors of the Society as well as non-members of the Board, was to review the professional, as distinct from the technical functioning of the Society and attempt to prepare for the general guidance of the officers and secretariat, a long-time program of meritorious activities for the Society. Some members felt, as a great executive recently so aptly stated, that anything which had been done the same way for five years was subject to challenge in a well-run concern.


J. P. H. PERRY

To review current activities was not very difficult. The real job was looking into the future. It may be interesting to run briefly over the studies and recommendations that the committee has made to date, and then to indicate some of the problems which must be solved in the future as we see it.

The committee adopted for its guidance the following three fundamental principles:

1. That the Society take immediate action in response to an unquestioned demand for expansion of activities looking towards the betterment of the professional and economic status of the engineer.

2. That such expansion of activities should not disturb the fundamental policies which have been responsible for advancing the Society to its present position of technical prestige, number of members, and financial soundness.

3. That any program for expansion of activities should not be unduly influenced by present economic or social conditions but should be founded on a long-term view of the problem.

Based on these three fundamentals the committee recommended:

1. That a summary of past public-relation and welfare activities of the Society be published in CIVIL ENGINEERING. This was done in February 1935, and is worthy of being reread by every member. The article lists an amazing number of accomplishments for the general welfare of members and of the profession generally. It is a fact, moreover, that the author constantly understated. Many beneficial things have been done by the Society officers and staff which it would be difficult to describe adequately.

2. That a Field Secretary be added to the staff of the Society. This was done in March 1935 by the appointment of Walter E. Jessup, M. Am. Soc. C.E. Since that date he has visited 52 Local Sections and 106 Student Chapters, and has traveled 48,000 miles. His mission has been two-fold:

a) To report to the Headquarters staff, and through it to the Board of Direction, his observations of the needs and desires of Society members; and

b) To carry to the membership a living picture of what the Society seeks to accomplish and does accomplish so well for them, to the end that fewer and fewer members shall think of the Society as a far-off, impersonal, technically successful organization located in Manhattan, which offers little more than various publications for the dues paid.

3. That registration (licensing) of engineers be actively stimulated.

4. That the correction of the abuses of civil service laws be sponsored.

5. That the principle of requiring Directors to visit Sections in their districts with expenses allowed be approved.

6. That more popular publicizing of the work of the Society and its membership be undertaken through some qualified expert.

7. That so far as advisable a Junior be added to all committees of the Society.

These recommendations were approved, and the Board of Direction, in January 1935, budgeted the sum of $25,000 for carrying them out.

Subsequently, additional recommendations were made to the Board of Direction and approved by it, as follows:

1. That the "Society Affairs" section of CIVIL ENGINEERING be expanded and made more attractive and more personal, having in mind that this is the only medium for transmitting information to the membership concerning the extensive non-technical activities of the Society.

2. That Local Section conferences be resumed with allotment of mileage one way to the meeting for one delegate for each Section within the region in which the Society meeting is held.

3. That a qualified full-time publicity expert be added to the Secretary's staff to give attention to matters of publicity relating to the work of the civil engineer. An appropriation of $8,000 was made to put this recommendation into effect, and W. R. E. Baxter was employed in January 1936.

4. The possibility of group life insurance at low cost was studied by the committee. After mature consideration and investigation, the committee reported that there is no practical way of presenting an attractive group-insurance plan for the members of the Society.

Other activities have been under consideration, and in several cases have been reported on to the Board without final action being taken by it. Among others the following may be mentioned:

1. The committee became convinced that in and through the Local Sections may be found the channel for the development and solution of the major problems that confront the engineer, the Society, the profession, and the relationship of all these to the life of the community. After an elaborate study of the functions of Local Sections, it therefore made a carefully considered report in detail to the Board of Direction in January 1936, which concluded with this statement: "Although recognizing the importance of the Local Section and the great value it can be made to the Society, your committee deems it prudent to go very slowly in making any radical changes in present policies until a thorough examination of the effect of any changes shall promise no hasty or unwise dissipation of Society funds; and that, pending further study of all the factors that may lead to, and be included in, a manual of Local Section functions and activities, conclusions as to the wholesale allocation of members to Local Sections and of all the correlative problems be deferred." This report on Local Sections was submitted to the Board of Direction in January 1936, and is still before the Board for consideration.

2. The functioning of Student Chapters was examined and found to be excellent. The Student Chapters act as membership feeders for the Society and generally have received enthusiastic cooperation from the university and engineering school authorities wherever they have been installed. There are now 114 such Chapters. In general, the activities and their results are of a high grade.

3. Junior forums have come into existence in several locations and give promise of meeting a need and of being an interesting development in the decentralization of the Society. These forums are being closely watched, but no recommendations are under consideration.

4. The stimulation and improvement of the merit or civil-service systems controlling the employment of engineers for governmental service—federal, state, and municipal—has been weighed and the conclusion tentatively reached that the problem is largely a local one so far as municipalities go and also to a certain extent in the states. The federal engineer employees are well organized and are doing an encouraging job in this regard.

5. The registration and licensing of engineers and the improvement of licensing laws now on the statute books has made excellent progress, and a standing committee of the Society is doing a fine job fostering this great movement.

6. The relationship between the Society and the Engineers' Council for Professional Development has been reviewed and found to be in very satisfactory shape. The Council gives great promise for the betterment of the future of the profession.

7. The whole committee structure of the Society, both technical and professional, is under study to see what improvements can be made along the lines of simplification and elimination of unnecessary or inactive committees.

So much for the past and the present. The future, I am frank to state, is hard to read, but it must be read if the Society is to continue the wonderful record it has made these past 84 years. Among the items we are considering are the following:

1. The preparation of a manual of direction and inspiration for the Local Sections and their detailed guidance.

2. Further strengthening of the Headquarters staff by the addition of two or more Assistant Field Secretaries.

3. Grouping of Local Sections along state lines.

4. Local Section get-together meetings in convenient localities.

5. The socialization of Annual Conventions in line with the conduct of meetings of architects, bankers, and lawyers, with more

emphasis on the humanities than on technical matters at such conventions.

6. Exchange speakers between engineers' conventions and architects' or lawyers' conventions.

7. The adoption of the Fellow or Senior grade of membership in the Society.

8. Closer and also broader relations with other engineering societies.

9. Pensions for the staff and perhaps some aid for widows and orphans of members that have been long on the Society rolls.

10. Adoption of a relationship between manufacturers and producers similar to the formal contract now in force between the American Institute of Architects and the Producers' Council to the end that wider employment of engineers may prevail.

11. The lessons to be drawn from the recent consolidation in Canada between the technical and professional groups.

12. The fact that there are 79 different engineering degrees awarded by technical schools in this country warrants the question as to whether in the future the Founder Societies may disintegrate into highly specialized organizations. If this trend develops, what should our Society policy be?

13. The effect on the Society of the recent security legislation and the railroad-merger labor agreements, plus old-age pensions, unemployment insurance, and minimum wage laws. Shall it get in step and undertake larger welfare and professional activities or shall it remain a highly technical organization and leave such problems to new organizations which may be organized to meet the demand for such activities?

14. Further efforts, probably through E.C.P.D., to improve the education and early training of engineers. Here, perhaps, lies the very greatest chance to get for Society members their "place in the sun."

One thing seems clear—the continuing benefit to the Society of a committee such as that on Aims and Activities. Many great banks and commercial institutions have auditing committees who report directly to the Board of Directors and are independent of the operating executives. When this committee was established as a permanent committee and enlarged to a membership of 9, composed of 3 Board members and 6 non-Board members, its objective was stated as being: "The initiating, energizing, and developing of Society policy looking toward the betterment of the professional and economic status of the engineer. To this committee should be referred all matters developed by the contacts of the Field Secretary with the membership and all problems involving the expansion of the public and human-relation activities of the Society. The committee shall be advisory only and shall report its conclusions and recommendations to the Board at least semi-annually."

The essence of this charter is in the words "initiating, energizing, and developing the Society policy with respect to the betterment of the professional and economic status of the membership."

Admiral Mahan, the famous naval authority, coined the phrase "a fleet in being." In one sense this committee may be regarded as "a fleet in being," the very existence of which acts as a stimulator and energizer of all other committees of the Society because it was the expectation of the Boards of Directors which created it that, acting solely in an advisory capacity to the Board, it would be free in a very wide sense to investigate the policies and functioning of any committees of the Society as well as to attempt the initiation (with the approval of the Board) of various new activities for the Society.

The committee has confined itself largely to a consideration of the last of its three duties. It has been and expects to continue to be most interested in attempting "to initiate new activities for the Society," and especially those designed to improve the professional and economic status of members. Few members question the technical preeminence of the Society. Many members have felt that the Society should do more for its membership along bread-and-butter or dollars-and-cents lines than it has. How far the Society can go in this direction requires wise counsel and much thought. It can be said most positively, however, that "much thought" is being given to this matter. How wise or successful the thinking will be, time alone can tell.

TRANSACTIONS—A New Volume

To be an all-round, expert civil engineer a man would need to be versatile indeed, and nowhere is the broad range of civil engineering thought and activity more strikingly demonstrated than in the papers of the new Vol. 101 of TRANSACTIONS. Reflecting another milestone in the steady progress of this profession through a world of modern improvements, this volume will provide the practicing engineer and the student with the most up-to-date thought on subjects ranging from bridges to canals, dams to power plants, economics to statistics and sun-spot cycles—in fact the subject index contains 76 topics, among which will be found papers of intrinsic value to every member of the Society. The author index contains 321 names.

Reference to any new volume of TRANSACTIONS would be incomplete without mentioning the section regularly devoted to the memoirs of deceased members. Too often a civil engineer bequeaths one or more enduring monuments to posterity without receiving reward or recognition at all proportionate to the importance of his work. In the memoir section of the TRANSACTIONS, the Society attempts to perpetuate the technical record of each man's contribution to the time in which he lived. These memoirs could not have been printed except for the whole-hearted efforts of the 101 individuals and committees who contributed hours of time, with attendant expense.

In this volume of TRANSACTIONS is also published the President's annual address by Daniel W. Mead, President and Honorary Member Am. Soc. C.E., entitled "The Engineer and His Code." This address was delivered by President Mead at the Annual Convention in Portland, Ore., on July 15, 1936. Closing discussions of three important papers appear for the first time in this volume, namely those by Hardy Cross, M. Am. Soc. C.E., on his paper entitled "The Relation of Analysis to Structural Design"; by Ellery R. Fosdick, assistant engineer in the Department of Public Service, State of Washington, on his paper entitled "Tunnel and Penstock Tests at Chelam Station, Washington"; and by E. C. Harwood, Captain, Corps of Engineers, U. S. Army, for his paper entitled "Proposed Improvement of the Cape Cod Canal." Memoirs are available for free distribution in limited number. Reprints of all papers are likewise available at Society Headquarters, the cost varying with each reprint, according to its size. In the purchase of reprints of publications, members receive a 50 per cent discount.

Volume 101 in paper-covered form will be distributed during the current month. It will appear as Part 2 of the October PROCEEDINGS, or the so-called TRANSACTIONS number. As the issue date is October 15, delivery should be completed a few days thereafter, through customary PROCEEDINGS channels. For the cloth and the morocco-bound issues, however, a special and separate delivery is required. Since these volumes are shipped by freight to various distribution points and from there by parcel post, their receipt cannot be expected until a somewhat later date.

In about 1,800 pages of text a vast amount of engineering thought and effort is represented. The entire profession is indebted to the many men who have conscientiously given their fellow engineers the benefit of their own study and practice.

In addition a tremendous amount of detailed work has been done by the Society's staff at Headquarters. Each page has been proof read. Errors that have come to light in PROCEEDINGS have been rectified. Printing programs have been arranged to ensure prompt delivery on schedule. Materials and labor for printing and binding have been selected and their use has been carefully supervised. The preparation and collation of envelopes and addresses have also been carried along in their proper sequences. The final chapter in the office procedure will take place after all these details are successfully carried out—the checking of bills for the work.

As far as the member is concerned, the packing, mailing, and delivery are perhaps the most important details. Printer, binder, and post office combine to handle this part of the work, which in itself is no mean task. At a unit weight of over 3 lb per volume, the total quantity to be handled approximates 50,000 lb.

Whether determined by weight alone, or more appropriately by technical content, Vol. 101 of TRANSACTIONS is a great accomplishment. It represents joint cooperation of many individuals; the result is certainly a credit to their efforts. It is hoped that in the hands of members and subscribers this TRANSACTIONS will find a wide and useful field of service.

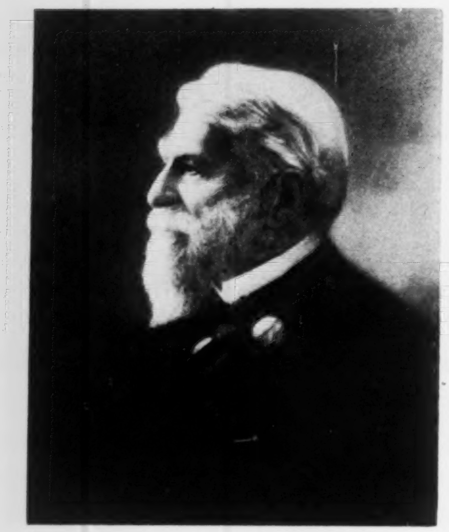
Early Presidents of the Society

In the widespread membership of the Society there must be many individuals who have known personally some of these early leaders, and others who have access to photographs or other interesting information in connection with their major works. Such persons are earnestly requested to assist in preparing this series of biographies by communicating with Society Headquarters. The subjects of the next three articles will be Ellis Sylvester Chesbrough, William Milnor Roberts, and Albert Fink.

VII. GEORGE SEARS GREENE, 1801–1899

President of the Society, 1875–1877

GEORGE SEARS GREENE was born when the nineteenth century was but five months old, and lived to within two years of its close. Whatever may have been his recipe for longevity, it quite evidently did not include "taking things easy." He began his civil engineering career when he was thirty-five; worked steadily at it until interrupted by the Civil War; served for four years in the Union forces, mostly at the front; and at sixty-five, released from service, he settled down to another twenty years of engineering practice.



GEORGE SEARS GREENE
SEVENTH PRESIDENT OF THE SOCIETY

Greene was born in prosperous circumstances, the son of a ship-owner of Apponaug, R.I. But within a few years of his birth the family fortune began to dwindle away. The War of 1812 finished what the Embargo Acts had begun, and young Greene, who had been looking forward to a university education, left home instead to look for work. He found it in New York. In 1819, however, he succeeded in obtaining an appointment to West Point. He graduated second in his class, and remained in the army for 13 years.

The first twenty years of Greene's engineering career were spent on railroad construction in various seaboard states from Maine to the Carolinas. In 1856, however, he was retained by the Croton Aqueduct Department to design structures for the extension of New York's water supply, and it is for this work that he is best remembered.

It had become necessary to construct a large distributing reservoir in what later became Central Park. There was at that time no similar work of equal magnitude to serve as a guide, and Greene introduced several novel features in design and construction to prevent seepage. For example, all the embankments were built up in thin layers, rolled with a grooved roller, and faced with a pavement of masonry set in a bed of concrete.

"Another novel practice was the use of concrete in large masses (rendered practicable by the invention of the stone crusher in 1858 by Eli Whitney Blake), and the reduction of cost and increase of specific gravity of the mass by the insertion of large unwrought stones" (Memoir, TRANSACTIONS, Vol. 49, page 335 et seq.).

The Croton water, it will be recalled, had been brought to New York by aqueduct in 1842. The bottleneck of the conduit was at the Harlem River, where the two supply pipes supported by High Bridge had but half the capacity of the remainder of the line. It soon became evident that this bottleneck would have to be removed. The problem fell to Greene, and here again he went beyond precedent by deciding in favor of a single pipe 90 in. in diameter. It was of wrought-iron, supported for its entire length of more than a quarter of a mile on saddles resting on rollers. The entire change of length due to temperature changes was taken up in a stuffing box at each end of the bridge.

About this time he also introduced an innovation in the design of large cast-iron pipes, discarding the ordinary hub joint and casting the pipe as straight cylinders, with the joints made by half-sleeves bolted together.

This work was interrupted by the Civil War. Greene went to the front as colonel of the 60th N. Y. Volunteers, was shortly commissioned as brigadier general, and served in that capacity with the Army of the Potomac and the Army of Northern Virginia. At Antietam, by virtue of seniority, he commanded the 2nd Division of the XII Army Corps, which "repulsed the enemy with signal loss to them."

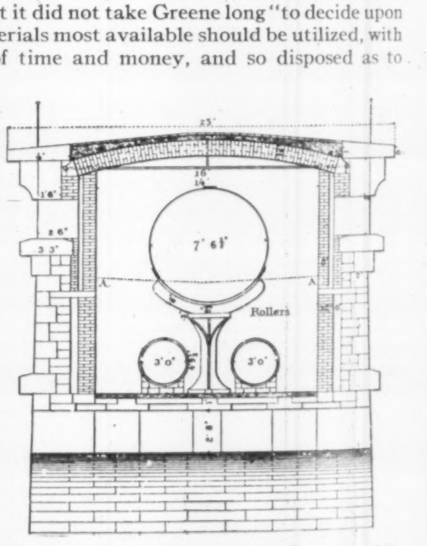
Next came Gettysburg. The *National Cyclopedia of American Biography* tells the story of his part in that battle: "With the XII Corps he arrived on the battlefield . . . late in the afternoon of the first day's fighting, was posted at Culp's hill, on the extreme right of the Union line, and helped to resist the Confederate attacks of the second day. That evening the entire corps, with the exception of Greene's brigade, was withdrawn in order to strengthen the Union left, and for a time this brigade bore the whole brunt of the renewed attacks of the Confederates, who could have placed themselves across the Union line of communications if the Culp's hill position were carried. The safety of the army, therefore, depended upon Greene's brigade, until, little by little, it was strengthened by troops sent from other commands."

In the fall of 1863 Greene's brigade was sent to Tennessee to reinforce the army at Chattanooga. On October 28 he fell, seriously wounded, at the battle of Wauhatchie at the foot of Lookout Mountain. But within a few weeks he had recovered sufficiently to perform court-martial duty, and in January 1865 he rejoined his brigade in the field in North Carolina. For "gallant and meritorious service" he was shortly thereafter commissioned brevet major general of volunteers. He was assigned to garrison and court-martial duties again, and was mustered out of service in April 1866.

Back in civil life at the age of 65, Greene had no thought of retiring. He returned to the New York aqueduct department. It had just been determined to construct additional storage reservoirs in the Croton Valley, and the first was to be at Boyd's Corners, in the upper reaches of the watershed in Putnam County.

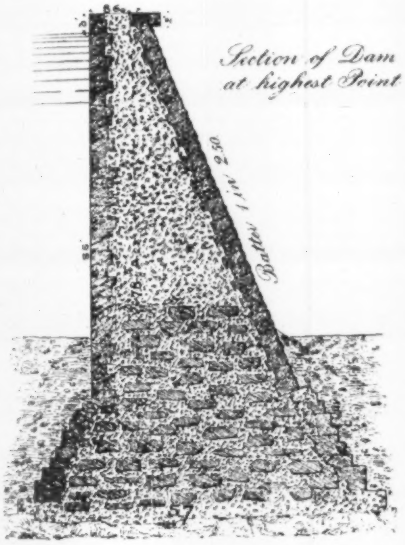
The dam was to be 78 ft in height from bedrock, and 670 ft long at the top—larger than any built in America up to that time. In fact, according to the Memoir, "there was no literature on the subject in the English language . . . . The only published discussion of the principles which should prevail in the design of high masonry dams was the treatise of Sazilly in the *Annales des Ponts et Chaussées*, in 1853." But it did not take Greene long "to decide upon a plan in which the materials most available should be utilized, with the least expenditure of time and money, and so disposed as to produce the most effective results"; and within four months the contract was let for construction.

The cross-section of the Boyd's Corners dam that accompanies this article is taken from a paper by J. James R. Croes (TRANSACTIONS, Vol. 3, page 337 et seq.). Mr. Croes indicates in his calculations that the resultant at the base of the trapezoidal portion would fall 8.7 ft from the downstream toe. (This is slightly outside the middle third, but is for the extreme and unusual condition of full reser-



THE OLD CROTON AQUEDUCT CROSSED THE HARLEM RIVER BY WAY OF HIGH BRIDGE
Drawing from Wegman's *Water Supply of the City of New York*

were normally there was a freeboard of 3 ft.) He goes on to say that when the Croton Aqueduct Department was succeeded by the Department of Public Works, in 1870, the new authorities were rather dubious about trusting the masonry of itself, and proceeded to put down a heavy earth fill on the upstream face. No care was taken to make this fill watertight, and Mr. Croes points out that it might well weaken the dam rather than strengthen it, by making "the pressure against the wall equivalent to that of a fluid of the same specific gravity as the earth." Whatever the merits of the later work, Greene's original design, considering the state of the art at that time, can scarcely be criticized.



The Dam at Boyd's Corners
From *Transactions*, Vol. 3, 1874

After the Aqueduct Department was superseded, Greene turned to other municipal work. He was for three years consulting engineer to the Morrisania Survey Commission, which inaugurated a system of exact topographical surveys and monumented base lines that was later extended widely in New York City. In 1875 he was made engineer of construction of streets and sewers, in the "Annexed District" that is now the Bronx.

"The most important of the works of which he had charge during this period was the main outfall sewer of Brook Avenue, which drains an area of 2,615 acres and has a gradient of only 1 ft in 2,618 ft. It is an arched brick conduit, 12 ft wide and 9.88 ft high . . . . The specifications for this work were very complete and thorough, and were deemed worthy of preservation as an example of what such a document ought to be, in the American reprint of Baldwin Latham's book on Sewerage, issued in 1877."

Between 1866 and 1880, Greene took an important part in preparing plans for various rapid transit projects for New York. He was one of the three engineers retained by the New York City Central Underground Railway Company, in 1869, to make a technical investigation of its proposed routes. This company had proposed a line from City Hall Park to the Harlem River; the engineers estimated that it would cost $17,600,000, and stated that it would be economically practicable. Capital was not forthcoming, however, to carry out their plans.

They went into considerable detail in the matter of motive power for the subway. Although reporting in favor of ordinary steam locomotives, they suggested that "hot water engines" were well worth considering. Under this system, the locomotive would be charged at each end of the line with sufficient water at 470 F to generate steam for the entire trip; this would eliminate the necessity for burning coal in the subways themselves, and the problems of ventilation would thereby be considerably simplified.

Greene later worked with other groups on similar projects, and on proposals for elevated railways as well. He was engineer for the Rapid Transit Commission of 1879, which established the route and prepared the plans for the crossing of the Harlem River at Eighth Avenue and 155th Street.

At the age of 82, he was called upon by the commissioners of public works to serve as one of the advisers on plans for the New Croton Aqueduct. Three years later he was appointed one of a board to investigate charges that had been made concerning the condition of the work then in progress. "Such was his physical vigor, even at his advanced age," says the Memoir, "that he insisted on walking through the entire length of the tunnels, examining closely everything as he went, a task to which his associates . . . found themselves unequal, although nearly twenty-five years his juniors. This was his last professional service, but he maintained his mental vigor and much of his physical strength until his death."

Greene has been described as "harsh in manner and a strict disciplinarian." But although "he was not a man to win immediate affection, . . . those under him soon learned to appreciate his ability and his rigid sense of justice" (*Dictionary of American Biography*). "In social life," says the Memoir, "he was fond of companionship, and was greatly beloved by a large circle of friends of all ages to whom the stores of information acquired in his long career . . . were freely unfolded." He helped to organize the Society in 1852, was a Director for five terms, and in 1888 was elected to honorary membership.

Three of his sons also attained prominence. Samuel Dana Greene (1840–1884) was a naval officer, and served as executive officer of the *Monitor* during the Civil War. Francis Vinton Greene is remembered as a soldier, historian, and civil engineer. In the Spanish-American War he commanded a brigade in the attack on Manila and was senior member of the commission that drew up the terms of capitulation of the Spanish Army. George Sears Greene, Jr., was also an engineer, and served for 22 years as engineer in chief of the Department of Docks, New York City. He was Treasurer of the Society for 3 years, was twice a Director and once a Vice-President. His son, Carleton Greene, served as Director in 1920–1922, and is still a member.

Texas Section to Hold Fall Meeting October 8 to 10

An interesting program has been arranged by the Texas Section for its fall meeting, to be held at Fort Worth, Tex., on October 8, 9, and 10, 1936. Headquarters for the meeting will be the Texas Hotel.

Addresses will be made by President Mead and Secretary Seabury, as well as by Vice-Presidents, Directors, and other visiting officials. The papers in general are of historical as well as technical significance, covering the development to date of municipal engineering, public utilities, the packing-house and allied cattle industries, the construction industry, railroad construction, highway building, and the petroleum industry in Texas. A paper will also be delivered on special construction features of the Frontier Centennial at Fort Worth. The speakers include many prominent engineers.

A visit will be paid to the Fontier Centennial on October 9, and to the Central Centennial Exposition at Dallas on October 10. An attractive program has also been arranged for the ladies. All Society members are cordially invited to attend and participate in this meeting.

American Engineering Council

The Washington Embassy for Engineers, The National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

Activities of Government Agencies

Behind the scenes in Washington, two fundamental truths are being recognized. The first is that the wide-flung government organization which has been set up under many of the New Deal agencies must be reassembled and consolidated. The second is that in such agencies as PWA, WPA, and the National Resources Committee, the blunt facts of engineering truth are persuading those who have been guiding the expenditure of government appropriations that several of the proposals are impossible of accomplishment. There are, of course, many currents of thought in this whole situation, but it is fair to say that the kind of thinking that engineers stand for is coming to be looked upon as essential.

No matter who is President, fundamental changes must be made if the money is to be spent effectively by the federal government for flood control, public construction of all kinds, and the many government projects involving the conservation of natural resources.

Up to the present time, there has been too much opinion and too few facts. It is now evident on the basis of the various surveys that have been conducted (almost as a side issue of the emergency objectives) that the facts so developed will influence methods and objectives as they have not done before. The procedure must be, first, to find what the facts are, and then to develop plans and put into execution projects which are based on these facts. Reflections of this are seen in the abandonment of certain activities of the Resettlement Administration, in the reshaping of the policies of the Rural Electrification Administration, and in the moves by Secretary Ickes to associate conservation and public works under one single division of the government.

THIRD WORLD POWER CONFERENCE

The Third World Power Conference opened its doors on September 7. Advance notices of the various papers presented indicated that a mass of engineering data would be presented, with emphasis especially on the social and economic phases of power development. American Engineering Council, in addition to staging the exhibit described later, held open house during the week of September 7 for visiting delegates from both this country and abroad. An indication of the size of the conference is the fact that the Washington Union Station was used for the banquet hall to accommodate the three thousand dinner guests, there being no private or public hall in Washington capable of caring for this number of persons. Genuine efforts were made by those in immediate charge of the conference to prevent this huge gathering from becoming a sounding board for social theories as to power development and utilization. In the preparation of preliminary papers, every effort was made to keep the discussion of government ownership versus private ownership on the basis of fact and logic rather than on that of theory and desire.

A graphic presentation of the engineering organizations of the United States and their "instrumentalities" forms a part of the exhibit of the conference. The exhibit and a special brochure were presented by American Engineering Council's committee on publicity for the engineering profession, as a contribution to furthering a public understanding of the work and purposes of the engineer. Both the exhibit and the brochure bring for the first time into a composite whole the picture of the engineering organizations of the United States.

The exhibit itself is unique and interesting. The central feature is a huge map of the United States measuring approximately 12 by 15 ft. On this map are spotted the locations of the national engineering societies and their local sections, the state engineering societies, and the independent local engineering groups. Grouped around the central feature are panels on which are presented the names and salient features of (1) the four national Founder Societies, (2) the instrumentalities or functional organizations, which are supported by the Founder Societies and by other national engineering bodies, (3) the list of 53 national engineering societies, (4) panels showing the names and locations of the state engineering associations and the local engineering organizations.

Brief descriptions of the objects and purposes of each of the functional organizations are presented on their respective panels. These functional organizations are as follows: United Engineering Trustees, Inc., The Engineering Foundation, National Research Council, American Standards Association, Engineers' Council for Professional Development, American Engineering Council, Engineering Societies Employment Service, and Engineering Societies Library. The color scheme of the exhibit is blue, white, and gold, and the charts and panels were prepared in such a way that they can be readily disassembled and erected at future exhibits.

The brochure, in addition to containing descriptions of each of the functional organizations, lists the name, secretary, membership, and principal activities of 53 national engineering societies, 40 state associations, and 96 local organizations. It contains also a brief article entitled "Why the Engineer" contributed by Dr. William F. Durand, chairman of the conference and the John Fritz Medalist for 1935. Greetings from the engineers of the United States to the delegates to the conference were conveyed in the booklet, signed by the members of Council's committee on publicity for the engineering profession.

Washington, D.C.
September 15, 1936

Alabama Engineers' Registration Board Appointed

FOLLOWING the passage by the Alabama legislature in 1935 of an act requiring the registration of all engineers and land surveyors, a state board of registration has been appointed.

The act provides that at any time within a year of its becoming effective, any professional engineer or land surveyor shall be granted a certificate if he submits to the board of registration proof that he is of good character, has been a resident of the state a year preceding his application, and was practicing his profession at the time the act became effective. All others who wish to have certificates must take an examination given by the board.

Three members of the Society—Chairman A. C. Polk, Vice-chairman J. A. C. Callan, and J. B. Converse—are on the board.

In and About the Society

LISTS of Society members who were recently awarded honorary degrees appeared in the July and August issues of CIVIL ENGINEERING. Since these numbers went to press, Grover C. Dillman, M. Am. Soc. C.E., was awarded the degree of doctor of engineering by the Michigan College of Mining and Technology. This award was made on August 6, immediately following his induction into office as president of the college.

* * * *

THE 62 members of the Society resident in China have been invited to become members of the Association of Chinese and American Engineers. Similar invitations have been extended to members of the other Founder Societies, and the association proposes to sponsor an annual conference of these groups to be held jointly with its own annual meeting.

* * * *

A POLICY of "dues to fit the individual pocketbook" has been adopted by the Cleveland Section. Formerly the dues of that Section were $1.00 per annum. This year the statement mailed to each member reads, "Dues for year 1936: $1.00, $2.00, $3.00," and instructs the recipient to cross out the figures not applicable when sending his remittance. The Section hopes in this manner to increase its income, and at the same time to keep the privileges of membership within reach of all. A recent report indicates that the plan is working out successfully; early contributions averaged well over $1.50 each.

Appointments of Society Representatives

JOHN P. HOGAN, M. Am. Soc. C.E., has been appointed a Society representative on the United Engineering Trustees for a three-year term, beginning October 1, 1936.

THADDEUS MERRIMAN, M. Am. Soc. C.E., will again represent the Society on the Research Procedure Committee of the Engineering Foundation.

GEORGE A. ORROK, M. Am. Soc. C.E., represented the Society at a Conference on Letter Symbols for Heat and Thermodynamics, held on September 14 at the headquarters of the American Society of Mechanical Engineers.

CHARLES E. TROUT, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on the Board of the Engineering Societies' Library for the four-year term, October 1936 to October 1940.

L. C. WASON, M. Am. Soc. C.E., is the Society's representative on the sectional committee for the Safety Code for Construction Work, formulated under the procedure of the American Standards Association.

FRANK E. WINSOR, M. Am. Soc. C.E., has been appointed a Society representative on the Engineers' Council for Professional Development, for the three-year term, October 1936 to October 1939.

Preview of Proceedings

By Harold T. Larsen, *Editor*

The October issue of "Proceedings" is unique in several respects, notably in that it will contain nothing but papers and in that it comprises a symposium of all the papers to be presented at the forthcoming meeting of the Structural Division to be held in Pittsburgh, Pa., on October 14 and 15, at the time of the Fall Meeting of the Society. The details of the program are published elsewhere in this issue.

Structural Applications of Steel and Light-Weight Alloys

In the past the designer of civil engineering structures has dealt with a more or less standard alloy of iron. His problem has been, for the most part, to adapt his structure to this standard material. Manufacture on a vast scale has made possible the development of standard equipment with resultant economy. The idea of "tailoring" the material to suit the design, which has gained impetus by developments in the automotive industry, is beginning to attract the attention of designers of bridges and other large structures.

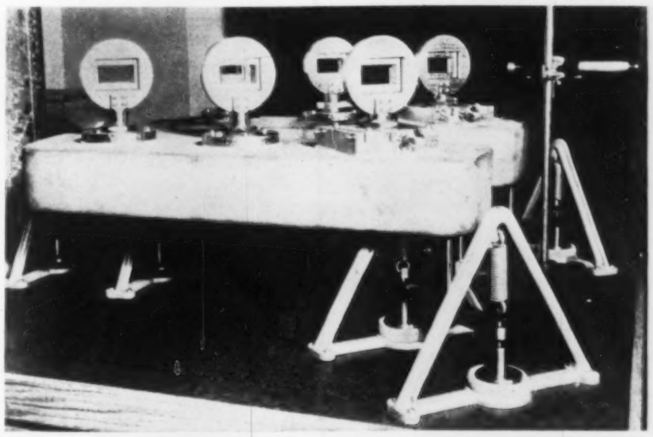
For the topic of discussion at the October meeting in Pittsburgh, the Structural Division has prepared a four-session symposium on the subject, "Structural Applications of Steel and Light-Weight Alloys."

It has required the preparation, comparison, and harmonizing of twelve papers in all, to give consistency and unity to this symposium. Furthermore, the committee in charge has taken the unusual step of having all papers prepared well in advance, acted upon by the Committee on Publications, and revised for presentation in the October number of Proceedings. The several papers cover the constitution and properties of special structural metals and the various factors affecting their suitability for use in bridges, buildings, and like structures, and at this time such a survey should prove of great and lasting value.

The symposium is introduced with a foreword by Jonathan Jones, M. Am. Soc. C.E., chairman of the Structural Division. Part I of the symposium is entitled "Modern Stress Theories and Fatigue Research."

Modern Stress Theories

The opening paper in the symposium, entitled "Modern Stress Theories," is by A. V. Karpov, M. Am. Soc. C.E. As its title implies, it covers a broad field and forms a fitting background for each of the papers that follow. It contains many interesting statements calculated to jar the conventional designer out of his "rut," and to warn him against the blind use of traditional methods of stress analysis, and the application of such analyses to design. The paper emphasizes the importance of fatigue stresses, and of the shape factor, in design. Mr. Karpov also offers an interesting review of research in the field of alloys, suggests a method of approach to the problem of stress concentration, and discusses the decrease in the value of the safety factor during the life of a structure. Among the topic headings offered are the following: Engineering Design as a Probability Problem; Changes in Engineering Attitude Toward Materials and Design Assumptions; The Extent of Present Theoretical Knowledge; Properties of Metals and Alloys of Importance in Structural Design; Fatigue Properties; Improved Design Methods; Joints; Safety Factors; Regions of Permissible Stress Variation.



New Interferometer Used by the U. S. Bureau of Reclamation for Direct Determination of Principal Stresses

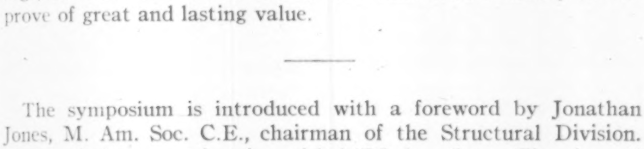
Tests of Engineering Structures and Their Models

The second paper of the symposium entitled "Tests of Engineering Structures and Their Models," by R. L. Templin, M. Am. Soc. C.E., could well serve as a convenient check list for use in modern testing laboratories. It is confined to a discussion of tests of structural members to determine deflections, stresses, and general procedure under given loads. The details of standard testing methods are described, and consideration is given to similarity conditions, materials used in models, and testing apparatus re-required. The paper is in two primary parts, the first dealing with types of engineering structures and the tests to be considered in relation to them, and the second with test methods. Part of the paper considers, at some length, the size of models and the materials required and the testing of models made of the same material as the prototype and of models of different materials from the prototype.

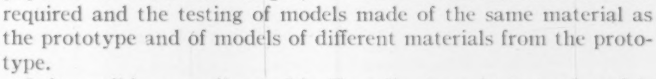
It is possible, according to Mr. Templin, to make tests of models which will give satisfactory results when the purposes of the test are: (1) To check the theoretical analysis; (2) to provide data as a basis for changes in design rules; (3) to check the efficacy of any proposed alteration in the construction; (4) to supplement theoretical analysis by experimental analysis; (5) to avoid theoretical analysis by resorting to experimental analysis; (6) to provide a quicker, easier, and usually inexpensive means of obtaining the desired information; and (7) to provide a means for checking the behavior of the design under loading conditions not possible with a full-sized structure.

Photoelastic Determination of Stress

A qualitative review of the photoelastic method of stress analyses is contained in the paper by Dr. J. H. A. Brahtz, who is with the U. S. Bureau of Reclamation at Denver, Colo. This paper, which is entitled "Photoelastic Determination of Stress," contains an interesting discussion of equipment and materials, of the applica-



Polarizing Unit of Polariscope
Model and Loading Mechanism on the Extreme Right



Analyzing Unit of a Polariscope
Calibration Machine Can Be Seen to the Left of the Reflector

tions and limitations of the photoelastic process, and of the comparison of this process with other means of stress analysis and measurement. Speaking of the future possibilities of this modern device, Dr. Brahtz states that photoelasticity has demonstrated its value and that it has established itself firmly as an invaluable tool for the engineering profession.

Its development has been positive, if somewhat erratic, and has by no means reached its limit. New model materials, apparatus, and technique are being developed. As lighter and stronger, but more expensive, alloys assume their natural function in construction, it will be more important than heretofore to have a complete knowledge of stresses, and as these demands become more acute, there will be more and more emphasis upon photoelasticity as a means of designing economical structures. The accompanying photographs show the polarizing and analyzing unit of the reflector-polariscope used at the U. S. Bureau of Reclamation.

In Part II, four papers are presented under the broad heading, "Metallurgical and Manufacturing Aspects of Ferrous and Light-Weight Alloys of Interest in Structural Design and Fabrication."

LOW-ALLOY STRUCTURAL STEELS

The first paper in this section should be of considerable help to engineers in the design of steel structures. It is entitled "Low-Alloy Structural Steels" by E. C. Bain and F. T. Llewellyn, M. Am. Soc. C.E. It shows clearly the metallurgical aspects of special grades of steel, and contains a summary of present manufacturing conditions. This work could also be read with profit in connection with the Progress Report of Subcommittee No. 2, Committee on Steel of the Structural Division, which was published in the March 1936 issue of PROCEEDINGS. Messrs. Bain and Llewellyn present information to show how the economical expenditure of the steel dollar may warrant the purchase of special steels that differ from common structural steels in the introduction or addition of alloying elements. This paper will be helpful in improving the engineer's acquaintance with common alloying elements, describing the direct and indirect influence of their presence upon the properties of structural steel. The primary characteristics of each alloying element by itself are discussed in some detail.

STAINLESS HIGH-ALLOY STRUCTURAL STEELS

To M. J. R. Morris, chief metallurgical engineer of the Republic Steel Corporation of Massillon, Ohio, has been assigned the second paper of Part II, entitled "Stainless High-Alloy Structural Steels."

This short paper is divided into four parts, the first of which outlines the various types of steel that might be included under the general title of "stainless steel." The second part deals with the physical properties of such steels, the third treats the problems of manufacture, and the fourth presents a series of examples of the possible application of stainless steel in practice. Among such applications, Mr. Morris cites interesting examples of the use of stainless steel in the construction of dams, sewage disposal plants, water supply intakes, reinforced concrete structures, and irrigation.

LIGHT-WEIGHT STRUCTURAL ALLOYS

The third paper, "Light-Weight Structural Alloys," is written by Zay Jeffries, consultant for the General Electric Company and the Aluminum Company of America; C. F. Nagel, Jr., chief metallurgist of the fabricating division of the Aluminum Company of America; and R. T. Wood, chief metallurgist of the American Magnesium Corporation. It is essentially a broad treatment of the physical and mechanical properties of light-weight alloys, and has been arranged in two parts, Part 1 dealing exclusively with aluminum alloys, and Part 2 with magnesium alloys. Civil engineers who have not had direct access to current publications on metallurgical subjects will find much information in this paper arranged in a particularly useful manner. It contains a discussion of metallurgical principles involved in the design of aluminum and magnesium alloys, the effects of various fabrication processes, and the applicability of the finished product to the structures with which civil engineers are most often required to work.

SLIDING AN EXTRUDED PILASTER MEMBER INTO PLACE IN THE WALL OF A BUILDING

Considerable progress has been made in the standardization of structural shapes and details of aluminum alloys. For example, there are plates weighing as much as 2,000 lb apiece. Although there are limitations to the size of certain alloys and tempers, such plates are now available to widths of 120 in. and lengths determined by the 2,000-lb weight. Extruded shapes, especially, have been gaining in favor because they permit of efficient and economical disposition of the metal where it is most needed. The accompanying photograph shows an extruded architectural section being slid into position.

CORROSION IN RELATION TO ENGINEERING STRUCTURES

Under the title, "Corrosion in Relation to Engineering Structures," James Aston, metallurgist of Pittsburgh, Pa., has contributed a paper of considerable educational value, especially in view of the marked increase of interest in the problems of corrosion in metals. The paper is concise and informative, being a comprehensive review of the general phenomena of corrosion and the effects of corrosion upon the selection of suitable metals for engineering structures. Mr. Aston distinguishes between the following three classes of corrosion: (1) Atmospheric, in which oxygen is the most serious factor, (2) immersion, in which corrosion is produced by opposite effects from atmospheric corrosion; and (3) soil corrosion, an intermediate classification between the two extremes. In the judgment of Mr. Aston, special materials, even at a higher cost, are sometimes justified from the viewpoint of corrosion alone. Parts of a structure, such as bridge floor members that cannot be reached by ordinary maintenance methods but which are exposed to the elements, are subject to a fast rate of deterioration from corrosion. This is true also of submerged structures. In all special cases, it is good engineering to select a non-corrosive material.

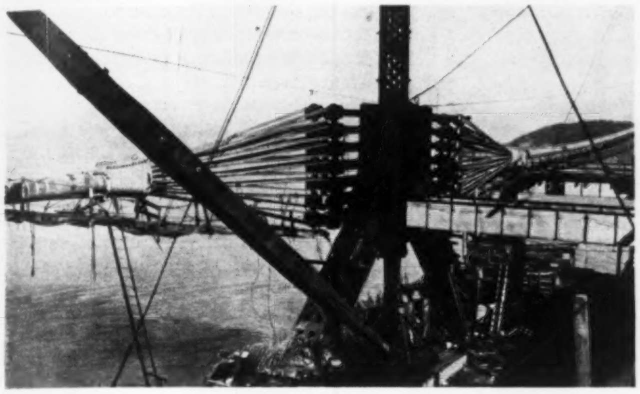
Part 3, which includes two papers, is confined to the subject of "Structural Applications of Special Steels."

ACTUAL APPLICATION OF SPECIAL STRUCTURAL STEELS

In the past when structural designers, for the most part, considered steel simply as "structural steel," they could pay a minimum of attention to the metallurgical factors of their problems, choosing sections from standard handbooks. However, with the newer consciousness of the economic advantages of different types of steel alloys to serve different purposes, the structural designer must now be more familiar with the metallurgical phases of this subject. In the first paper in the Symposium entitled "Actual Application of Special Structural Steel," V. D. Beard, M. Am. C.E., gives the civil engineer a clear description of this subject from the viewpoint of the steel fabricator.

Evolution of High-Strength Steels Used in Structural Engineering

The other paper, entitled "Evolution of High-Strength Steels Used in Structural Engineering," by Leon S. Moisseiff, M. Am. Soc. C.E., could well serve as a background for the entire symposium. The datum plane, so to speak, of Mr. Moisseiff's thesis is the so-called ordinary structural steel, to which the terms "high-strength" and "higher-strength" steels are referred for comparison.



Connection of Two Cables of the San Francisco–Oakland Bay Bridge

The paper is descriptive rather than purely technical. Beginning with the wrought-iron era, Mr. Moisseiff outlines the social and economic conditions of American life that lent impetus to the demand for grades of iron alloys of specified chemical compositions to suit particular purposes. The reasons for using stronger steels are given, with examples of many of the large bridges in this country. The advantages and limitations of the higher strength steels are shown. In the future it will not be possible to think of a bridge or any other structural frame simply as a steel structure. Henceforth, the structure must be individualized, the various parts being patterned after different specifications to suit differences in the type of behavior. For the student of structures, this paper will serve as a foundation upon which he may build; and the engineer of training and experience, to whom many of the facts presented in the paper are known, will find it useful in systematizing his ideas and in supplying a stable background for the newer facts that are constantly being discovered in this field.

Part 4, which is entitled "Light-Weight Structural Design," consists of three papers.

Application of Stainless Steel in Light-Weight Construction

The opening paper in this section, entitled "The Application of Stainless Steel in Light-Weight Construction," by E. J. W. Ragsdale, of the Edward G. Budd Manufacturing Company, is a good treatment of a timely subject. Being intimately associated with the construction of railway equipment, Mr. Ragsdale reveals some interesting facts pertaining to the use of a special grade of chromium nickel steel in the construction of cars. The paper contains an interesting outline of the possibility of using stainless steel to produce lighter structures. It emphasizes a number of points that need careful consideration in the design of members, their details and connections, and calls attention to methods of fabrication in current use and those in the process of development.

Structural Applications of Aluminum Alloys

A highly interesting and informative paper entitled "Structural Applications of Aluminum Alloys" has been written by E. C. Hartmann, Assoc. M. Am. Soc. C.E. This paper applies to structural aluminum as the papers by Messrs. Beard and Ragsdale apply to the special structural steel alloy. After describing fully the characteristics of a standard grade of structural aluminum, Mr. Hartmann turns his attention to fabrication problems, which the structural designer of the future must understand fully, in order to take advantage of the most modern developments in his field. Leaving the shop and its peculiar problems, Mr. Hartmann turns his attention to the designing room and points out the various important differences between designing in structural steel and designing in structural aluminum. A reviewer of this paper has stated that it "should be a valuable guide to prospective designers of structural aluminum alloys."

Magnesium Alloys and Their Structural Applications

A paper that reveals valuable information on magnesium alloys in general terms, with particular application to the requirements of the structural engineer, is entitled "Magnesium Alloys and Their Structural Applications," by A. W. Winston, of the metallurgical department of the Dow Chemical Company. Although the information contained is new, it is adequately substantiated by facts and tests. The underlying purpose of this paper is to present the characteristics of the standard magnesium alloys in which the civil engineer is most likely to be interested, in order that he may arrive at a proper appreciation of their possibilities in design. The author claims that, with the introduction of stronger alloys and improved fabrication processes, the way is now open for the development of additional structural applications. The civil engineer is most likely to make use of magnesium alloys in cranes, booms, scaffolds, ladders, and other portable tools.

News of Local Sections

Georgia Section

A meeting of the Georgia Section was held in Atlanta on August 10. After discussion of unfinished business and of the engineers' registration law, Howard T. Cole, the speaker of the occasion, was introduced. Mr. Cole, who is engineer inspector for Alabama, Georgia, and Florida, gave an interesting talk on the government in business, pointing out that, as far back as 1916, the government was giving 50 per cent grants for highway construction. A "fish fry," held at the Vinings Hills Country Club on August 21, was enjoyed. The program of entertainment included sports and games, for which prizes were awarded. There were 110 present, including 25 members of the Section.

San Francisco Section

On July 14 the San Francisco Section held a special dinner meeting at the Engineers' Club in honor of President Mead and Secretary Seabury. There were 70 present. Mr. Seabury gave an intimate picture of current Society activities. He was followed on the program by Dr. Mead, who discussed the advisability of basing a code of ethics on what should be done in engineering work rather than on what should not be done. The regular bimonthly dinner meeting of the Section was held at the Engineers' Club on August 18, with 110 members and guests present. During the business session proposed revisions to the Section's constitution and by-laws were presented by the Welfare Committee. A paper on the "Design and Construction Features of the Bonneville Project" was then presented by C. I. Grimm, head engineer of the North Pacific Division of the U. S. War Department. This talk was illustrated with slides.

Texas Section

At the regular monthly meeting of the Fort Worth Chapter of the Texas Section, which was held on July 11, officers were elected for the coming year. These are as follows: T. E. Bliss, president; D. L. Lewis, vice-president; and H. A. Hunter, Secretary-Treasurer. The guests at the meeting included Lt. Frank G. Johnson, of the U. S. Coast and Geodetic Survey, and J. T. L. McNew, Secretary of the Section. Lieutenant Johnson told of some of the newer methods of coastal surveying and described the exhibit sponsored by the Survey at the centennial exposition in Dallas.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for November

FEW EARLY civil engineers occupy such an important place in the profession as Thomas Telford, 1757–1834, pioneer in bridge, canal, and road construction. The activities of the first 36 years of Telford's life are described in an interesting article scheduled for the November issue, by J. F. Baker, Assoc. M. Am. Soc. C.E., professor of civil engineering at the University of Bristol, England, assisted by John Armitage. This article, which is abstracted from the first of a group of Professor Baker's lectures to appear in CIVIL ENGINEERING, covers Telford's career as county engineer of Salop, Shropshire, England, and the establishing of his engineering reputation through the design and construction of the 112-mile Ellesmere Canal, connecting the valleys of the Mersey and Severn. In his work, Telford made novel use of both wrought-iron and cast-iron. His structures are notable for boldness of design, based for the first time upon the strength of materials as determined experimentally.

The use of hydraulic models as an aid in the design and construction of large dams, first used extensively by the U. S. Bureau of Reclamation in 1930, has proved to be of considerable value. Following the article, "Models Cut Costs and Speed Construction," in the current issue, describing the Bonneville models, the November number will present articles on models used in the projects at Grand Coulee and Fort Peck, by Jacob E. Warnock, Assoc. M. Am. Soc. C.E., hydraulic research engineer of the Bureau of Reclamation, and Gail A. Hathaway, M. Am. Soc. C.E., senior hydraulic engineer, U. S. Engineers, respectively.

In the case of the Grand Coulee Dam, four different models were tested in an attempt to develop a method of protection against scour at the toe of the proposed overflow spillway. These models also provided valuable information on transverse wave and pool action; erosion of river bed; design of spillway training walls, crest, and drum gate; and diversion problems arising during construction. For the Fort Peck project, hydraulic model studies were made of the spillway, one tunnel and the control structures, the complete tunnel outlet works, and the dam proper. Objectives included the most efficient hydraulic design for the spillway structure and the most efficient means of dissipating kinetic energy at the end of the spillway paving. Nine model earth-fill dams were built in the course of studies to determine the suitability of the various soils available at the site for an earth-fill dam, and to aid in designing a stable dam section.

If space permits, an article entitled "Correlating Ground and Air Survey Methods," by Arthur W. Lambert, Jr., of the U. S. Engineer Corps, St. Louis, Mo., will be included in the November issue. This paper presents very clearly the principles of the art of making maps from air photographs, or photogrammetry, as the process is called. After discussing the underlying theory, Mr. Lambert describes the operation of the stereoplanigraph, the machine which makes possible accurate stereo-mapping and contouring. Air photography fulfills a long-felt need in making maps of large inaccessible or economically inaccessible areas because of its low cost and because it permits complete centralization of the actual cartographic work of the topographical staff.

National Safety Congress to Be Held October 5 to 9

SEVERAL thousand members of the National Safety Council are expected to attend the Twenty-Fifth National Safety Congress and Exposition, to be held in Atlantic City, N.J., October 5–9, 1936.

Nearly 400 speakers will emphasize accident prevention, and separate programs have been arranged for the cement, chemical, construction, mining, marine, petroleum, public utilities, and other sections. Owing to the nation-wide interest in the National Safety Council's five-year campaign to cut motor vehicle deaths 35 per cent by the end of 1940, saving at least 38,000 lives, much attention will be focused on the street and highway traffic section.

Wise and Otherwise

DURING the past summer, Professor Abercrombie purchased a farm containing 6 acres of pasturage. Wishing to utilize the grass to the best advantage over the maximum growing season of 6 weeks, he decided to stock the farm with a sufficient number of sheep to eat all the grass initially in the pasture and all that should grow within the 6-week period. One of the farmers in the neighborhood stated that 3 sheep would eat in 2 weeks all the grass on 2 acres of land, together with all the grass which might grow there in that time. Another gave it as his experience that 2 sheep would eat in 4 weeks all the grass on 2 acres of land, together with all the grass which might grow there in that time. From this information the Professor quickly computed the proper number for his own conditions, previously cited. How many sheep did he thus determine to buy?

In September's problem, a lighthouse showed revolving red and white lights, making circuits through north, east, south, and west, at a rate of one and two minutes, respectively, with coincidences at the north point. An observer noted that the red light faced him at a certain time, then again one minute later, followed by the white light at the expiration of 21 seconds. The observer's bearing from the lighthouse is required.

Brief study will show that, if the observer had been at the east point when he first saw the red light (then on its second circuit after coincidence), the white light would have passed 75 seconds later; if at the south point, 90 seconds later; and so on to coincidence at the north point. Evidently the maximum difference in time of passage, which will occur just prior to coincidence, approaches 120 seconds as a limit. The white light thus falls behind at the rate of 720 deg in 120 seconds, or 6 deg per second. In 81 seconds it will therefore have fallen behind 486 deg, and will give a bearing of S 54 deg E. It is interesting to note that the bearing could have been computed equally well had the first passage of the red light been unobserved.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

Standards Bureau Announces Recommendations

CIVIL ENGINEERS will be interested in several recent simplified practice recommendations of the U. S. Bureau of Standards, which are now available in printed form. Penetration limits for asphalt for various uses are covered in R4-36, Asphalt, which became effective June 15, 1936. Recommendation R1-36, Vitrified Paving Brick, is concerned with sizes and varieties, and went into effect on June 30. Recommendation R147-33, Wire Diameters for Mineral Aggregate Production Screens, in effect since 1933, has been reaffirmed without change. Copies of each can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at 5 cents.

Until ready in printed form, mimeograph copies of the following recommendations can be obtained gratis from the Division of Simplified Practice, National Bureau of Standards, Washington, D.C.: R3-28, Metal Lath (sizes and varieties, effective July 1, 1936); and R58-28, Classification of Iron and Steel Scrap, also effective July 1.

Driving Tests May Reduce Highway Accidents

Ways of minimizing highway accidents and the resulting serious loss of life are being studied from the angle of driver psychology and physical condition. A psychological approach to this problem is described by Dr. Charles S. Myers, principal of the National Institute of Industrial Psychology, and his article in *Nature* as reported in *Highway Research Abstracts* No. 28. It has been estimated, says Dr. Myers, that the human factor enters into 80 to 90 per cent of all highway accidents. Tests to evaluate this factor are therefore valuable.

Motor-driving tests devised and installed by the National Institute of Industrial Psychology assess the following elements separately: Speed of appropriate reaction to a given signal, resistance to distraction, ability to attend to several things at once, vision, judgment of size and speed, self-confidence, road behavior, and manipulative ability. Some of these tests assess qualities which may improve with practice but others deal with qualities not susceptible of improvement. When applied in the selection of drivers, these reduce the likelihood of accidents. Results give a satisfactory degree of correlation with drivers' records.

Another research on driving skill was conducted as an FERA project in 1934–1935, under the direction of Harry de Silva, professor of psychology at Massachusetts State College. As reported in *Highway Research Abstracts* No. 28, published by the National Research Council, the purpose of the investigation was to devise laboratory equipment with which to test the automobile driver and to develop a scientific foundation on which to base a program for improving his driving ability.

The following tests were devised: (1) Braking-reaction; (2) steering—miniature and full-size; (3) speed-and-timing estimation; (4) visual for (*a*) glare-blindness, (*b*) movement perception, (*c*) depth perception, (*d*) tunnel vision, (*e*) visual acuity, and (*f*) color-blindness; (5) auditory; (6) general, including the training of drivers, comprising (*a*) miniature highway driving tests, (*b*) moving picture driving tests, and (*c*) use of an experimental road car; (7) tests for fatigue and other physiological handicaps.

One piece of equipment measures the time required to take the foot from the accelerator and apply pressure to the brake. The signal to apply the brake is given by a regulation traffic signal. For over 4,000 people tested, the average reaction time was around 0.44 sec. The shortest time recorded was 0.24 sec, and the longest was 1.00 sec. Youths about 23 years of age showed the shortest reaction time. Beyond this age the time lengthens gradually with increased years. In many cases, the reaction time was 0.20 sec longer when the subject was taking a steering test at the same time. The steering tests, which simulated keeping a car in its proper lane, showed good correlation with driving experience.

Iowa Planning Board Studies Traffic Regulations

To emphasize the need for uniform and scientific traffic control, the Iowa State Planning Board recently issued a report on existing traffic conditions and regulations in 13 cities of that state. The analysis was based on answers by city officials to a questionnaire prepared by the American Road Builders' Association.

Answers to questions on design and construction suggest that much may be done in the matter of safe and economical street design. Officials of ten cities indicated a belief that smooth street surfaces are contributing to traffic accidents, and seven of them believed it would be good public policy to make an expenditure for a nonskid surface over the existing one.

Traffic volume has increased to such an extent in four cities that it has become necessary to consider the construction of an elevated highway. These cities believed that a system of public garages in connection with such highways would stabilize property values in the commercial districts. Only two cities, however, felt that the voters would look with favor on such a project.

A great variation was indicated in traffic-control mechanisms, signs, and signals. Neighboring cities use different colors to indicate identical signals. Only five have "progressive-movement" signal systems. One city still permits a right turn on a red light. Two maintain their signals in operation 24 hours a day, and of the eleven others only three indicate that the signal is off and that a stop is required. In spite of the apparent need for uniformity in methods and systems, four cities still feel that a uniform nation-wide system of traffic-control mechanisms and colors to indicate definite orders should not be adopted.

Pedestrians are required by law to obey traffic signals and move with the lights in 9 cities out of the 13, but only one city has assessed fines for violations.

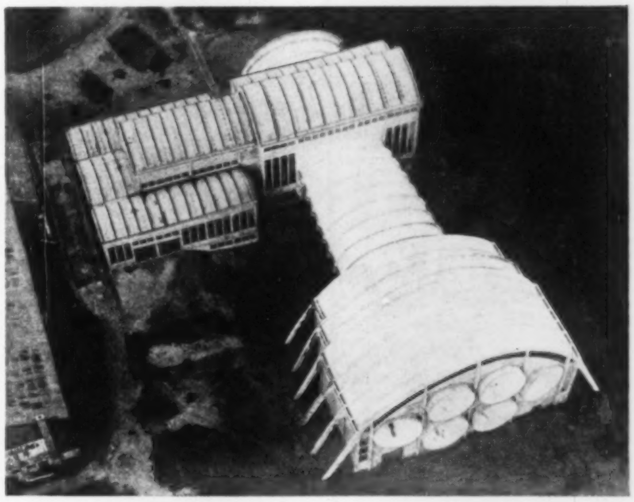
Aviation Makes Great Progress in Europe

Swift progress of European aviation is challenging American supremacy in the air, according to Stephen J. Zand of the Sperry Gyroscope Company, who returned last spring from a six months' study of flying there. Dr. Zand, in an address at the New York Museum of Science and Industry, reported that the larger European countries have passed the United States in the intensity of their research, and with their huge wind tunnels, towing basins, and other testing equipment threaten to snatch our laurels. "The major world records of speed, distance, and duration are held abroad," he said. "Due to the urgent needs of European countries, aircraft with remarkable performance are being produced in unparalleled quantities. European air lines are learning from American air transport operation that travelers by air want speed with comfort and are developing transport planes which are comparable to our latest developments."

In France, according to Dr. Zand, the sensation of the minute is the *pou de ciel*—the "flying flea" or "sky louse." "It is a two-winged affair with the front wing movable and acting as elevators. There are no ailerons—only a rudder. Its originator asserts that the ship will bank automatically as soon as the rudder is applied.

"The back yards of many mechanics or of many people who formerly were builders of radios," Dr. Zand continued, "have become tiny airplane factories." The motorcycle industry saw the opportunity to stage a comeback and has put on the market amazingly small engines of 15 to 30 hp. "Parts of the airplane can be bought in the French equivalent of our 5 and 10 cent stores. A 'sky louse' can be constructed, engine and propeller, for about $700. Clubs have formed and in many a little field in France you can see on Saturday and Sunday numbers of men working on their jointly owned airplanes.

"Accidents have happened, but they fly. I have flown one, but cannot see how the man in the street can make much headway with this little plane. I expect that this year there will be between 300 and 400 of them in existence."



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The Gigantic Wind Tunnel at Chalais-Meudon, France
Wind Velocities as High as 113 Miles per Hr Are Produced by Six Propellers Exhausting Through the Circular Ports in the Foreground. At Its Smallest Section the Elliptical Tunnel Is 52 Ft Wide and 26 Ft High

Standardizing the Measurement of Sound

Much has been said and written in recent years about the noise problem. The first step in the scientific control of noise is the establishment of loudness standards. The second is some means for accurately measuring sound intensities so as to determine how loud a noise must be to be considered objectionable. In this connection the American Standards Association has recently approved, as Tentative Standards for Noise Measurement, a system of units, scales, and definitions for use in measuring the loudness level of all types of sound. As reported in a recent issue of *Industrial Standardization and Commercial Standards Monthly*, the Association has also set up Tentative Standards for Sound Level Meters, which make it possible to obtain the same results for the same sound when measured by any type of standard meter.

Some units of measurement must be expressed in relation to a fixed point or value—such as sea level, in the case of altitude. The "datum" used in measuring sound is called the "reference level." The difference between the intensity level of a given sound or noise and the reference level is measured in units called "decibels." A noise may vary in intensity between zero decibels, which is the threshold of hearing as measured in a soundproof booth, and 126 decibels, the threshold of pain. The sound of ordinary breathing at a distance of 1 ft is about 10 decibels; that of a loud whisper or a soft voice at 2 ft, about 45 decibels; that of heavy street traffic at 50 ft, 85 decibels; and that of a riveter at 35 ft, about 105 decibels.

But while the intensity level is a physical quality, the loudness of a sound as heard by the ear depends to some extent upon its frequency as well as upon the observer's judgment. To guide this judgment a reference tone has been selected and loudness has been defined. By definition the loudness level of any sound is the intensity level of an equally loud reference tone having a frequency of 1,000 cycles per sec. As the frequency of slight sounds decreases from 1,000 cycles per second, more and more intensity is required to make them audible. But intense sounds, such as those of 90 decibels, are almost equally loud as the frequency is decreased. By making comparisons of the 1,000-cycle reference tone with sounds having frequencies and intensities throughout the audible range, a set of curves has been developed by the use of which any pure tone can be used for judging the loudness level of a noise.

An instrument to measure the intensity of sound or noise is termed a "sound level meter." Such a meter consists essentially of four parts—microphone, weighting network, amplifier, and indicating mechanism. In the microphone some of the acoustic energy is converted into electrical energy. The weighting network is required because the ear does not interpret all sounds of equal acoustic pressures or intensities as equally loud if differences in frequencies exist. In this network, therefore, the electrical energy corresponding to certain frequencies must be attenuated in order to secure a loudness measurement more nearly in accord with the perception of the human ear. An additional control is usually added to keep the meter needle on the scale, owing to the wide range of powers which the ear perceives but which the scale of a simple electric meter cannot accommodate. The indicating instrument is marked in decibels.

These meters are valuable as they are easily transported, will take many measurements in a short time, and more particularly, will give the same value for the same noise at different times. Meters built and calibrated in accord with the new standards will agree among themselves, regardless of make.

It is expected that the adoption of the new loudness standards will make it possible to write more definite specifications regarding noise conditions. The adoption of such specifications, in conjunction with the use of standard sound level meters for testing and enforcement, should in the end bring about a desirable reduction in noise.

The work of the Sectional Committee on Acoustical Measurements and Terminology, which resulted in setting up the two standards previously mentioned, has been ably reported by Stephen E. Slocum, M. Am. Soc. C.E., who is the Society's representative on the committee. The committee, organized under the auspices of the Acoustical Society of America in January 1932, comprises representatives of 28 technical societies and industrial groups. The standards (on Noise Measurement and Sound Level Meters for Measurement of Noise and Other Sounds) were approved by the American Standards Association in February 1936 and are now available in pamphlet form at the headquarters of the association, 29 West 39th Street, New York, N.Y., at a cost of 25 cents each.

Brief Notes from Here and There

Rome, Italy, is to be host to the International Bureau of Technical Education on the occasion of its next congress, December 28–30, 1936. Members of the Society who are interested in securing the necessary credentials for attendance, or who know of others now abroad who may wish them, are asked to communicate with Society Headquarters.

* * * *

On October 1 to 11, 1936, in Berlin and Munich, Germany, the International Association for Bridge and Structural Engineering will hold its second international congress. This congress promises to be of special importance to engineers both on account of the scientific papers and in view of the excursions to Dresden, Bayreuth, and Berchtesgaden which are planned to enable the participants to inspect the new German motor roads and other structures of technical interest. A preprint volume of 1,600 pages, containing the papers for the congress, has been published in German, French, and English by the Secretariat of the Association, located at the Federal Institute of Technology, Zurich, Switzerland.

* * * *

Detailed specifications and minimum standards for trench and tunnel timbering are given in the revised edition of "General Orders on Tunnel, Caisson and Trench Construction" issued in June by the Industrial Commission of Wisconsin. The 48-page pamphlet also includes regulations established by the commission in regard to fire protection, use of explosives, work under compressed air, and a number of other subjects bearing upon the safety of workmen. James L. Ferebee, M. Am. Soc. C.E., is chairman of the advisory committee that prepared both the first (1930) edition and the present revision. Another member of the committee is George W. Rauch, Assoc. M. Am. Soc. C.E.

* * * *

Demolition of Waterloo Bridge, a famous London landmark, is now nearly complete. Dedicated on the second anniversary of the battle of Waterloo—June 18, 1817—this bridge was one of three built by John Rennie over the Thames. For more than a century its sturdy masonry arches withstood the hammering of city traffic. Finally, in 1924, partial failure occurred as a result of settlement of two of the piers. Repairs were made, but the dimensions of the bridge were inadequate for modern traffic, and two years ago it was decided to replace it. *Civil Engineering* (London) for May 1936 carries a complete description of the unusual methods employed in the demolition.

NEWS OF ENGINEERS

Personal Items About Society Members

Thomas J. Leahy, formerly assistant engineer for the Denver Municipal Water Works, is now an associate engineer with the U. S. Bureau of Reclamation, in charge of investigating the Yampa project in Colorado.

Harry D. Chapman was recently appointed engineer inspector for PWA on the Los Angeles Aqueduct project, with headquarters at Independence, Calif. Previously Mr. Chapman was city engineer of El Cerrito, Calif.

W. Sherman Smith, assistant professor of civil engineering at the University of Toledo, has been appointed city traffic engineer of Toledo, Ohio.

Ross A. Harbaugh is now sales engineer for the Ross-Tacony Crucible Company, of Philadelphia, Pa.

E. W. Kramer, for a number of years regional engineer for the U. S. Forest Service, has recently been appointed regional director of the Federal Power Commission for seven western states. His headquarters are in San Francisco, Calif.

Richard A. Hart, who was previously acting state director of the Public Works Administration for Utah, is now state director.

James H. Polhemus, chief engineer and general manager of the port of Portland, Ore., for the past seventeen years, has been appointed executive vice-president and director of the Portland Electric Power Company.

Adelbert J. Newman is now an inspector for the U. S. War Department in Los Angeles, Calif. Previously he was in the water department of the city of Long Beach, Calif.

Boyne H. Platt, formerly village manager of Wilmette, Ill., has become superintendent of the department of buildings, grounds, and construction at Iowa State College, Ames, Iowa.

James H. Le Van has been relieved from duty as assistant district engineer for Interstate Sanitary District No. 3 of the U. S. Public Health Service at Chicago, Ill., and assigned to the staff of the Stream Pollution Investigation Station at Cincinnati, Ohio.

Franklin O. Rose has been appointed to the staff of the University of Southern California, where he will be assistant professor of general engineering in charge of courses in engineering drawing and hydraulics. Previously he was an instructor in engineering and mathematics at Modesto Junior College, Modesto, Calif.

Ralph A. Watson, formerly an engineer for the Allison Steel Manufacturing Company at Phoenix, Ariz., is now structural engineer for the Darbyshire Harvie Iron and Machine Company, of El Paso, Tex.

William E. Stanley has resigned as hydraulic and sanitary engineer for Pearse, Greeley, and Hansen, of Chicago, Ill., to accept the position of professor of sanitary engineering in the school of civil engineering at Cornell University.

J. D. Whittaker, who was in the employ of the Windpass Gold Mining Company, Ltd., at Boulder, B.C., is now assistant engineer for the British Columbia Pulp and Paper Company, Ltd., at Woodfibre, B.C.

A. A. Brielmaier, formerly an assistant engineer in the U. S. Engineer Office at Los Angeles, Calif., is now in the civil engineering department of the University of Illinois.

Clyde E. Swank has entered the employ of the Public Works Administration at Miami, Fla. Previously he was project engineer for the Florida State Road Department.

Russell G. Hackett is now senior engineer in the San Francisco regional office of the Federal Power Commission. Previously he was senior hydraulic engineer for the same organization at Burlingame, Calif.

Gilbert H. Friend, senior engineer for the U. S. Engineers at Zanesville, Ohio, has been promoted from the position of chief of the railroad section to that of chief of the engineering division of the Muskingum Watershed Conservancy project.

Harry H. Steinhauser, who has been employed as field-office engineer for the Tennessee Valley Authority at Chattanooga, Tenn., is now resident construction engineer for the Puerto Rico Reconstruction Administration in charge of the construction of the Dos Bocas hydroelectric station. His headquarters are at Guayama, Puerto Rico.

Carl A. Hoglund has been appointed principal engineer of the inventory and pricing branch of the Bureau of Valuation of the Interstate Commerce Commission at Washington, D.C. This new branch comprises what was formerly the roadway and track, cost, bridge, building, signal, telegraph and telephone, and mechanical branches.

Parry W. Owens is now with the Andrew Weston Company, Inc., of Whitesboro, N.Y.

Reidar Olafsen, formerly designing engineer for the Union Carbide Company at Niagara Falls, N.Y., is now an associate structural engineer with the Tennessee Valley Authority at Knoxville, Tenn.

Albert R. Ellis, previously vice-president of the Pittsburgh Testing Laboratory at Pittsburgh, Pa., is now president of the same organization.

Edwin W. Burritt, formerly state engineer of Wyoming, has resigned to serve as special engineering counsel for the state in the North Platte River litigation.

Carl W. Brown has been promoted from the position of assistant chief highway engineer of the Missouri State Highway Department to that of chief highway engineer of the same organization. His headquarters are at Jefferson City, Mo.

John C. Beebe, formerly senior civil engineer for the U. S. Forest Service at San Francisco, Calif., was recently appointed assistant regional forester in charge of the division of engineering, California Region 5, U. S. Forest Service.

W. Fred Starks, who has been county engineer of Nassau County, N.Y., since 1922, recently resigned to go into private practice.

James A. Thompson has left the employ of the Minneapolis Brewing Company, in Minneapolis, Minn., to become an engineer and accountant for the South St. Louis Slate and Tile Roofing Company, of St. Louis, Mo.

Harald M. Westergaard is leaving the University of Illinois, where he has been professor of theoretical and applied mechanics, to become Gordon McKay professor of civil engineering in the graduate school of engineering at Harvard University.

Paul G. Thom, formerly under-engineering-aide in the engineering service division of the Tennessee Valley Authority at La Follette, Tenn., is now with the Bethlehem Steel Company in Cleveland, Ohio.

Howard D. Eberhart has resigned from the Bonneville Dam design office to become an instructor in the civil engineering department of the University of California.

Floyd R. Rowley, a junior engineer with the Standard Oil Company of California, has been transferred from the Bahrein Islands in the Persian Gulf, where he was employed on the construction of an oil refinery, to Suez, Egypt, to become resident engineer on the construction of a fuel-oil bunker loading plant.

John A. Clark, following completion of a new sewage-treatment plant at Ashland, Ore., on which he was resident engineer, has rejoined the engineering staff of the Alameda County Mosquito Abatement District of California as sanitary engineer. His headquarters are at Oakland, Calif.

William M. Spann has resigned as state director of the Public Works Administration for Missouri to assume active management of the Tuttle, Ayers, Woodward Company, engineers and surveyors, of Kansas City, Mo.

Dugald C. Jackson, formerly professor of electric power production and distribution and head of the department of electrical engineering at the Massachusetts Institute of Technology, has been made professor emeritus.

Albert H. Pollard is now acting engineer of materials and tests for the Texas State Highway Department, with headquarters at Austin, Tex. Previously he was assistant engineer of materials and tests.

Temple B. Ingram, who has been employed by the Texas State Highway Department as resident engineer at Olton, Tex., was recently transferred to Quitaque, Tex., where he is resident engineer of Briscoe County.

Ulysses S. Grant, 3d, colonel, Corps of Engineers, U. S. Army, has been made chief of staff of the Second Corps Area of the U. S. Army at Governor's Island, N.Y. Colonel Grant was in command of the First Engineers at Fort du Pont, Del., before being ordered to his new post.

John P. Koch, formerly in the service of the Public Works Administration in Louisville, Ky., is now in the Corps of Engineers, U. S. Army, at Vicksburg, Miss.

WALTER E. KROENING, formerly with the Milwaukee Sewerage Commission, has entered the employ of the Resettlement Administration in Washington, D.C., where he is assistant chief engineer and acting chief engineer in charge of all engineering work for the Greendale, Wis., suburban housing project.

ROBERT DUDLEY HAYES is now sales engineer for the Johns-Manville Sales Corporation, of Atlanta, Ga. Formerly he was a draftsman and estimator for the Georgia State Highway Board.

EMERICH JONY, formerly in the U. S. Engineer Office at Philadelphia, Pa., is now with the Federal Power Commission in New York City.

CYRUS K. HOWARD has established a general contracting practice in Oklahoma City, Okla., under the name of C. K. Howard and Company. Previously he was an engineer with the Standard Paving Company, of Tulsa, Okla.

LOUIS V. DEL FAVERO has been appointed a junior agricultural engineer in the U. S. Soil Conservation Service. His headquarters are Camp SCS–Pa-3, at Slickville, Pa.

JOHN F. PARTRIDGE is now office engineer in the construction division of the Tennessee Valley Authority, employed on the construction of Fowler Bend Dam. Formerly Mr. Partridge was in the construction plant section.

JOHN C. KING, JR., formerly a junior engineer in the U. S. Bureau of Reclamation at Denver, has gone to Istanbul, Turkey, to become a member of the staff of Robert College.

DECEASED

MOSES BURPEE (M. '84) consulting engineer for the Bangor and Aroostook Railroad, Houlton, Me., died on August 18, 1936. Mr. Burpee, who was born at Sheffield, New Brunswick, Canada, on February 25, 1847, specialized in railroad engineering. During his long career he was connected with several Canadian lines and with the Chicago, Milwaukee, and St. Paul Railway. From 1885 to 1891 he was maintenance engineer for the New Brunswick Railway and later for the Canadian Pacific Railroad, with which the New Brunswick Railway was merged. In 1891 he entered the employ of the Bangor and Aroostook Railroad, as chief engineer, becoming consulting engineer in 1929.

EDWARD IVAN CLAWITER (M. '20) chief engineer for the Hydraulic Dredging Company at Oakland, Calif., died on August 12, 1936, at the age of 57. Mr. Clawiter was born at Mount Eden, Calif., and graduated from the University of California in 1900. From 1903 to 1915 he was engaged on engineering projects in several foreign countries, including the Philippines and South America. During this period he was employed by the Atlantic, Gulf, and Pacific Company; J. G. White and Company; and the Trussed Concrete Steel Company. From 1916 to 1930 he was chief engineer and secretary of the San Francisco Bridge Company, becoming connected with the Hydraulic Dredging Company in the latter year.

FREDERICK HOSMER COOKE (M. '21) C.E.C., U. S. Navy, died at the Naval Hospital in Chelsea, Mass., on August 28, 1936. Captain Cooke was born in Cincinnati, Ohio, on March 11, 1879, and graduated from the Massachusetts Institute of Technology in 1900. In 1904, after holding civil positions in Cleveland, Boston, and Portsmouth, N.H., he was commissioned an assistant civil engineer in the U. S. Navy, with the rank of lieutenant. During his long career in the navy Captain Cooke served in the Philippines, in Europe, and at numerous naval stations here. From 1912 to 1916 he was in charge of the design of coaling plants, dry docks, and floating cranes in connection with the construction of the Panama Canal. At the time of his death he was yard and 1st naval district public works officer at Boston.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

CONWAY ROBINSON HOWARD (Assoc. M. '06) of Richmond, Va., died in Asheville, N.C., on August 26, 1936. Mr. Howard, who was 55, was born in Richmond. In 1900, following his graduation from the Virginia Military Institute, he entered the employ of the Chesapeake and Ohio Railway, where he remained until 1907, rising to be first assistant to the division engineer. From 1924 to 1926 and from 1929 to 1934 he was also with this railroad. He was employed by the Great Southern Lumber Company and the Great Northern Railroad from 1910 to 1917, and from 1919 to 1921 was assistant to the technical advisor of the Republic of Austria. During the war Mr. Howard served in France as first lieutenant of the 17th Engineers.

JACOB DUNCAN JAQUES (Assoc. M. '10) construction engineer for the New Jersey Zinc Company (of Pennsylvania), Palmerton, Pa., died on September 10, 1936, at the age of 57. Mr. Jaques was born in Woodbury, N.J., and graduated from the University of Pennsylvania in 1901. From 1902 to 1909 he was with the Philadelphia Rapid Transit Company on the construction of the Market Street subway and elevated railroad. From 1913 to 1917 he superintended building construction for the New Jersey Zinc Company at Palmerton, Pa., and during the war he was a lieutenant in the Civil Engineer Corps, U. S. N. R. F. Mr. Jaques was in business for himself as a construction contractor from 1921 to 1925. In the latter year he became assistant construction engineer for the Philadelphia Department of City Transit, where he had charge of construction of part of the Broad Street subway. In 1934, he became division engineer on construction of the high-speed line over the Delaware River Bridge at Philadelphia. In 1936 he reentered the employ of the New Jersey Zinc Company.

GEORGE HENRY KIMBALL, SR. (M. '90) consulting engineer of Pontiac, Mich., died on August 8, 1936. Mr. Kimball was born at Newburyport, Mass., on December 8, 1849, and was educated at the Massachusetts Institute of Technology. During his long engineering career he was employed in various capacities—such as superintendent of bridges and buildings, engineer of maintenance of way, and chief engineer—by the Pittsburgh, Cincinnati, and St. Louis Railway; the Columbus, Sandusky, and Hocking Railroad; and the New York, Chicago, and St. Louis Railroad Company, among other roads. In 1906 he established a general consulting practice in Pontiac.

VICTOR SARGENT LORENZ (Assoc. M. '24) died in the Veterans Administration Hospital at Oteen, N.C., on March 28, 1936. Mr. Lorenz, who was 46, was born in Los Angeles, Calif. Much of his engineering career was spent in foreign countries. During the war he served for two years in France, rising from the rank of sergeant to lieutenant in the engineer corps of the army. From 1920 to 1923 Mr. Lorenz was engineer on construction work for the United Fruit Company in Costa Rica. He was later engineer and superintendent for the Truxillo Railroad Company, and subsequently superintendent and construction engineer for the Northern Railroad Company at San Jose, Costa Rica.

RAYMOND RUDOLPH LUNDAHL (M. '25) special engineer in charge of grade-crossing elimination, Milwaukee, Wis., died on July 6, 1936. Mr. Lundahl was born in Gibson City, Ill., on July 9, 1889, and graduated from the University of Illinois in 1911. From 1912 to 1915 he was with the Chicago, Milwaukee, and St. Paul Railway, and from 1916 to 1927 he was with the Sewerage Commission of the City of Milwaukee, engaged in a variety of engineering capacities. In 1927 he was placed in charge of planning and executing all work in connection with grade-crossing elimination in Milwaukee and the adjacent metropolitan area. From 1928 to 1931 he was also a member of the Board of Harbor Commissioners of Milwaukee.

EDWARD FRANCIS O'BRIEN (Affiliate '29) construction engineer in the office of the supervising architect for the U. S. Treasury Department in Washington, D.C., died at his home in Brooklyn, N.Y., on August 27, 1936, as the result of an accident suffered on an inspection trip. Mr. O'Brien, who was born in Brooklyn, was 68 at the time of his death. From 1900 to 1908 he was successively superintendent of construction for two builders. In the latter year he became superintendent of construction of public buildings for the U. S. Treasury Department. Among the many important projects on which he was engaged were the postoffice annex in New York City, the Federal building in Brooklyn, and the development of the borough hall approach to Brooklyn Bridge.

Vincent Phillip Odoni (M. '16) died at his home at Beverly Hills, Calif., on August 9, 1936, at the age of 57. He was born in Lucerne, Switzerland, and educated at the Technical University of Zurich. After some early engineering experience in his native country, Mr. Odoni came to the United States in 1907. He was first employed by Arthur L. Sonderegger, consulting engineer of Los Angeles, Calif. In 1913 he became chief engineer of the Tucson (Ariz.) Farms Company, where he remained for a number of years. Subsequently he became chief civil engineer of the Haitian-American Sugar Company at Port-au-Prince, Haiti.

Milnor Peck Paret (M. '85) a retired consulting engineer of Lake Charles, La., died on August 16, 1936. He was born at Pierpont Manor, N.Y., and received a C.E. degree from Lehigh University in 1878. Mr. Paret's early experience was in railroad work, and from 1890 to 1910 he served as chief engineer of the Mexico and Orient Railroad. From 1910 to 1913 he was in private practice in Kansas City, Mo., and from 1917 until his retirement in 1920, maintained a consulting practice at Lake Charles, La. He was the author of articles on railroad construction.

Hugh Pattison (M. '13) died on August 20, 1936. Born in Cambridge, Md., on August 3, 1872, he graduated from Johns Hopkins University in 1892. Much of Mr. Pattison's career was devoted to the electrification of various elevated and railroad lines, including elevated lines in Boston, Brooklyn, and Chicago, and the Long Island and the West Jersey and Seashore railroads. From 1923 to 1933 he was engineer of electric traction for the Virginia Railway Company at Norfolk. In the latter year he took up duties as engineer on maintenance of equipment and design of new cars, for the Third Avenue elevated railway in New York City, where he remained until the time of his death.

Edward John Schneider (M. '09) for many years contract manager of the bridge and structural department of the Columbia Steel Corporation (a subsidiary of the U. S. Steel Corporation), San Francisco, Calif., died in January 1936. Mr. Schneider was born in Pontiac, Ill., in 1875, and graduated from the University of Illinois in 1900. Beginning in 1902, he served for a number of years with the American Bridge Company, where he was in charge of the design of bridges and buildings for various American cities.

Joseph Harrison Wallace (M. '01) a specialist in paper-mill engineering problems, died on July 7, 1936, at Hamilton, Ohio, at the age of 67. Mr. Wallace was a native of Worcester, Mass., and a graduate of Worcester Polytechnic Institute. In 1894 he became associated with A. B. Tower and Company of Holyoke, Mass., the firm which later became Tower and Wallace. In 1901 he started his own firm of J. H. Wallace and Company, which had offices in New York and England, and built many paper mills. During the war Mr. Wallace was a consulting engineer for the Ordnance Department of the army. From 1931 until his death he was consulting engineer for the Black-Clawson Company of Hamilton, Ohio.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From August 10 to September 9, 1936, Inclusive

ADDITIONS TO MEMBERSHIP

Abel, Stanford Edward (Assoc. M. '36), Vice-Pres., Hechinger Co. (Res., 4700 Connecticut Ave., N.W.), Washington, D.C.

Acton, Joseph Paul (Jun. '36), Senior Engr., WPA, Bear Mountain Park, Iona Island (Res., 31 Lake St., White Plains), N.Y.

Baker, Wilfred Harmon (Jun. '36), Chf. Surv. Draftsman, U. S. Forest Service, Box 349, Rutland, Vt.

Barber, Richard Lewis (Assoc. M. '36), Cons. Engr., Westerly Highway Comm.; Civ. Engr., 8 Spruce St., Westerly, R.I.

Bernstein, Joseph John (Assoc. M. '36), Associate Engr., U. S. Engrs., Boston, Mass.

Best, James Arthur (Assoc. M. '36), Asst. Civ. Engr., State Highway Dept. (Res., 402 Hanthorne St.), Mays Landing, N.J.

Blattler, Paul Xaver (Assoc. M. '36), With Remington and Goff, 509 Cooper St., Camden (Res., 125 Bettlewood Ave., Oaklyn), N.J.

Booker, James Lester, Jr. (Jun. '36), Technical Engr., State Engr.'s Office, PWA (Res. 522 Ridgeway St.), Little Rock, Ark.

Buzzell, Dow Alan (M. '36), Chf. Design Engr., Tricounty Project (Res., 822 North Kansas Ave.), Hastings, Nebr.

Cabaniss, Leslie Davis (Assoc. M. '36), Project and Res. Engr., State Highway Dept., 490 Lamar Ave., Paris, Tex.

Calvert, Cecil Kirk (Affiliate '36), Chemist and Bacteriologist, Experimental Engr. and Operating Engr., Indianapolis Sanitation Plant, Indianapolis, Ind.

Clark, George John (Jun. '36), Transitman, Philadelphia & Reading Coal & Iron Co., Ashland (Res., 114 Elm St., Shamokin), Pa.

Colosimo, Henry (Assoc. M. '36), Asst. Engr. of Constr., Emergency Work Bureau, Dept. of Health; 103–03 One Hundred and First Ave., Ozone Park, N.Y.

Cuevas Bustamante, Sergio Rafael (Assoc. M. '36), Constr. Engr., Puerto Rico Irrig. Service, Guayama, Puerto Rico.

Dastoli, Theodore (Jun. '36), Box 412, Lowellville, Ohio.

DeFazio, Peter George (Jun. '36), Rodman, RA, Hightstown (Res., 374 Morris Ave., Long Branch), N.J.

Drought, Francis Tunstall (Assoc. M. '36), Cons. Engr. (Lilly & Drought), 503 Frost Bank Bldg., San Antonio, Tex.

Druhot, George Stanley (Assoc. M. '36), Associate Topographic Engr., U. S. Geological Survey, Box 346, Sacramento, Calif.

Fasshauer, Walter Henry (Assoc. M. '36), Pres., Bear Eng. & Constr. Co., 1518 Summer St., Philadelphia, Pa.

Foster, Christopher Jerome (Jun. '36), Civ. Engr., Frederick Snare Corporation, 405 East Bluemont St., Grafton, W.Va.

Friend, Philip Stearns (Jun. '36), Computer, U. S. Coast and Geodetic Local Control Survey of New Jersey, 12 Bank St., Princeton, N.J.

Fristoe, Robert Edwin (M. '36), Chf. Engr., Galveston Wharf Co., Galveston, Tex.

Gaber, Bernard (Assoc. M. '36), Asst. Engr. (Designer), Board of Water Supply, 346 Broadway, New York, N.Y.

Goldenberg, Joseph William (Jun. '36), Care, St. Louis Structural Steel Co., Box 230, East St. Louis, Ill.

Gordon, Ronald Arthur (Jun. '36), Asst. Engr., State Highway Dept., McConnelsville, Ohio.

Harvey, Count (Assoc. M. '36), Associate Engr., U. S. Bureau of Reclamation (Res., 1378 Humboldt St.), Denver, Colo.

Hawley, Harry Holman (Assoc. M. '36), Designing Engr., Grade III, Bureau of Bridges, Dept. of Highways (Res., 2685 Deming Ave.), Columbus, Ohio.

Hickey, John Howard (Assoc. M. '36), Engr., Distrib. Dept., Elizabethtown Consolidated Gas Co., Elizabeth (Res., 404 East Lincoln Ave., Roselle Park), N.J.

Huie, Samuel Sze Lien (Jun. '36), Rodman, Marine Parkway Authority for Madigan-Hyland, 521 Fifth Ave. (Res., 400 West 160th St.), New York, N.Y.

Hyder, Kenneth Lee (M. '36), Asst. Vice-Pres., The Am. Appraisal Co. (Res., 525 East Michigan St.), Milwaukee, Wis.

Jansen, Jacques (Assoc. M. '36), Engr. of Constr., City of New York and U. S. Works Administration (Res., 290 Riverside Drive), New York, N.Y.

Jenson, Theodore Bruce (Jun. '36), Designing Engr., PWA Project Engr.'s Office, Minneapolis–St. Paul San. Dist. Project (Res., 4541 Forty-Third Ave., South), Minneapolis, Minn.

Jones, Malcolm Halley (Jun. '36), Junior Engr., U. S. Engr. Office, Galveston, Tex.

Kennedy, Daniel (Assoc. M. '36), Associate Topographic Engr., U. S. Geological Survey, Ozark, Mo.

Lancaster, Kenneth George (Jun. '36), Junior Plans Draftsman, State Highway Comm., 312 South Jefferson St., Junction City, Kans.

Layne, Arthur Robert (Jun. '36), 1461 Shrader St., San Francisco, Calif.

Luthin, John Christopher (Jun. '36), With Inspection Dept., East Bay Municipal Utility Dist., Oakland (Res., 1316 Ordway St., Berkeley), Calif.

MacDougall, Robert Leak (Assoc. M. '36), Care, WPA of Georgia, 10 Forsyth St., Atlanta, Ga.

McCain, John Irving, Jr. (Jun. '36), Junior Engr., SCS, Minden (Res., Colfax), La.

McCaughan, Frank Allan (Jun. '36), Insp. and Engr., Myers, Noyes & Forrest (Res., 4950 Gaston Ave.), Dallas, Tex.

McCoy, Herbert Virgil (M. '36), Asst. Constr. Engr., State Div. of Highways, East St. Louis (Res., 704 East Clay St., Collinsville), Ill.

Martin, Randolph Lee Arthur (Jun. '36), Insp., U. S. Engr. Office (Res., 316 South Graham St.), Pittsburgh, Pa.

Matthews, Charles William (Assoc. M. '36), Associate Town Planner, Suburban Resettlement Div., RA; 3321 Sixteenth St., N.W., Washington, D.C.

Means, Raymond Ellsworth (M. '36), Asst. Prof. of Architecture, Oklahoma Agri. and Mech. Coll., Stillwater, Okla.

Meissner, Harmon Stimbert (Assoc. M. '36), Associate Civ. Engr., U. S. Bureau of Reclamation (Res., 561 South Ogden St.), Denver, Colo.

Mohler, Franklin Calvin (Jun. '36), Junior Engr., SCS, U. S. Dept. of Agriculture, SCS, Iowa 22, Ottumwa, Iowa.

Morang, Clarence Nolan (Jun. '36), Junior Engr., U. S. Engr. Office, Hydr. Laboratory, Iowa City, Iowa.

Morton, Donald Ross, Jr. (Jun. '36), 1348 Lancaster Ave., Wilmington, Del.

Murray, Angus Norman (Jun. '36), Insp., Met. Water Dist. of Southern California, Div. 2, Headquarters, Rice, Calif.

Nunn, Henry Edwin (Assoc. M. '36), Supt., Water Works Impvt. Dist. 1 (Res., 317 Fayetteville St.), Van Buren, Ark.

O'Brien, Fred Ennis (M. '36), City Engr., City Hall (Res., 221 South Hamilton St.), Watertown, N.Y.

Owen, Mark Blynn (Assoc. M. '36), Vice-Pres. and Director, Nichols Eng. & Research Corporation, 40 Wall St., New York, N.Y. (Res. 7752 Kentucky Ave., Dearborn, Mich.).

Perrott, Thelo Albert (Assoc. M. '36), Asst. City Engr. (Res., 954 Forest Ave.), Palo Alto, Calif.

Peterson, Lawrence Kenneth (Jun. '36), Junior Topographic Engr., U. S. Geological Survey, Box 346, Sacramento, Calif.

Philbrick, William Hunt (Jun. '36), Chf. of Survey Party, State Highway Dept., Box 382, Keene, N.H.

Philippe, Robert René (Assoc. M. '36), Associate Engr., U. S. Engr. Office (Res., 650 Lenox Ave.), Zanesville, Ohio.

Prentice, Thomas Harold (Assoc. M. '36), Instr., Civ. Eng., School of Technology, Coll. of the City of New York (Res., 501 West 113th St.), New York, N.Y.

Price, Thomas Moore (M. '36), Project Mgr., Henry J. Kaiser and Component Companies, 1522 Latham Sq. Bldg., Oakland, Calif.

Retief, Everhardus Malherbe (Assoc. M. '36), Asst. Engr., South African Rys., Box 173, East London, Union of South Africa.

Richter, Victor John (Assoc. M. '36), Associate Agri. Engr., U. S. Dept. of Agriculture, SCS, Washington, D.C. (Res., 319 Cedar Ave., Takoma Park, Md.).

Rolfsen, Alf Justin (Jun. '35), 44 Franklin Ave., New Rochelle, N.Y.

Rupp, Carl Frederick (Jun. '36), Engr., WPA (Res., 210 Thirty-Sixth St.), Union City, N.J.

Ryan, Alfred Joseph (Jun. '36), 215 Thirteenth St., Knoxville, Tenn.

Saint, Frederick Gilman (Jun. '36), Lieut., C.E., West Point, N.Y.

Schrontz, Chalmers Clinton (M. '36), 2585 Oak St., Jacksonville, Fla.

Smith, Charles Henry (M. '36), Sewer Engr., Dept. of Public Works (Res., 6210 South East Main St.), Portland, Ore.

Streander, Philip Bertram (M. '36), Cons. Engr. (Watson & Streander), 11 West 42d St., New York, N.Y.

Sundaresan, Trichinopoly Visvanatha Iyer (Assoc. M. '36), Asst. Garrison Engr., 6/C Ulsoor Rd., Bangalore Cantt, South India.

Swanson, Victor George (Jun. '36), Designing Draftsman, State Rivers and Water Supply Comm., Melbourne C. 2, Victoria, Australia.

Thomas, Melvin Clay (Assoc. M. '36), Unit Chf., TVA, Eng. Service Div., Box 225, Decatur, Ala.

Thornley, Joseph Harry (M. '36), Pres. and Chf. Engr., Western Foundation Co., 308 West Washington St., Chicago, Ill.

Williams, Gordon Lee (Jun. '36), Junior Engr., U. S. Bureau of Reclamation (Res., 1566 Trenton St.), Denver, Colo.

Wisely, William Homer (Assoc. M. '36), Asst. San. Engr., State Dept. of Public Health, Capitol Bldg., Springfield, Ill.

Young, Guy Raymond (Jun. '36), Detailer and Designer, Detroit Rock Salt Co. (Res., 7080 Senator Ave.), Detroit, Mich.

Membership Transfers

Blumberg, Oscar Charles (Jun. '28; Assoc. M. '36), Chemist, California Water Service Co., Box 322, Concord, Calif.

Bradley, Joseph Newell (Jun. '30; Assoc. M. '36), Associate Engr., U. S. Bureau of Reclamation, Custom House (Res., 2637 Garfield St.), Denver, Colo.

Bruck, Henry Hans (Jun. '30; Assoc. M. '36), Concrete Technician, Golden Gate Bridge and Highway Dist. (Res., 495 Fulton St.), San Francisco, Calif.

Buchanan, Spencer Jennings (Jun. '26; Assoc. M. '36), Associate Engr., U. S. Waterways Experiment Station, Mississippi River Comm., Box 665, Vicksburg, Miss.

Burpee, Lawrence Hanington (Jun. '26; Assoc. M. '36), 4095 Côte des Neiges Rd., Apartment 1, Montreal, Quebec, Canada.

Callahan, Arthur Francis (Assoc. M. '25; M. '35), Managing Director, Refrigerator Assoc. of New York, Inc., 60 East 42d St., New York, N.Y.

Campbell, Philip, Jr. (Jun. '28; Assoc. M. '36), Chf. Draftsman, The Texas Co., Box 712, Port Arthur, Tex.

Connington, Charles Simpson (Jun. '27; Assoc. M. '36), Sales Engr., Reilly Tar & Chemical Corporation, 500 Fifth Ave., New York (Res., 488 Murray St., Pelham Manor), N.Y.

Critser, William Harold (Jun. '28; Assoc. M. '36), Designing Engr., Div. of Eng. and Constr., City of Columbus, City Hall (Res., 137 Crestview Rd.), Columbus, Ohio.

DeWitt, Don Robert Smithwick (Jun. '30; Assoc. M. '36), Senior Insp., Met. Water Dist. of Southern California; 3341 Chestnut St., Riverside, Calif.

Ellis, Robert Richardson, Jr. (Jun. '28; Assoc. M. '30; M. '36), Engr., Frederick Snare Corporation, Apartado 200, Cartagena, Colombia.

Evans, William Norman (Jun. '30; Assoc. M. '36), Chf. of Party-Estimator, Met. Water Dist. of Southern California, 3d and Broadway, Los Angeles (Res., 807 South Maryland, Glendale), Calif.

Frederick, Harry Arthur (Jun. '33; Assoc. M. '36), Laboratory Asst., Public Service Elec. & Gas Co., 938 Clinton Ave., Irvington (Res., 399 Lincoln Ave., Orange), N.J.

Furr, Manford W. (Assoc. M. '23; M. '36), Prof., Civ. Eng., Kansas State Coll., Manhattan, Kans.

Gain, Elmer William (Jun. '30; Assoc. M. '36), Administrative Eng. Asst. to Dist. Engr., Bureau of Agri. Eng., U. S. Dept. of Agriculture, Box 755, Milwaukee, Wis.

Harrold, Lloyd Larren (Jun. '30; Assoc. M. '36), Associate Hydr. Engr., SCS, U. S. Dept. of Agriculture (Res., 1425 Van Buren St., N.W.), Washington, D.C.

Hasselbach, William Henry (Jun. '27; Assoc. M. '36), Constr. Engr., Libbey-Owens Ford Glass Co. (Res., 3861 Lockwood Ave.), Toledo, Ohio.

Kerr, George Watson (Jun. '31; Assoc. M. '35), Asst. Materials Engr., State Highway Dept., Div. 5, 307 Trust Bldg., Newark, Ohio.

Landwehr, Waldemar John (Jun. '30; Assoc. M. '36), Engr., Madison Met. Sewerage Dist., 302 Tenney Bldg., Madison, Wis.

Mavis, Frederic Theodore (Jun. '23; Assoc. M. '26; M. '36), Associate Director, Iowa Inst. of Hydr. Research; Prof. and Acting Head, Dept. of Mechanics and Hydraulics, Univ. of Iowa, Hydraulics Laboratory, Univ. of Iowa, Iowa City, Iowa.

Nobes, Herbert Eric (Jun. '29; Assoc. M. '36), Valuation Engr., North Eastern Constr. Co., 101 Park Ave. (Res., 1393 Undercliff Ave.), New York, N.Y.

Paulet, Emile George (Jun. '28; Assoc. M. '36), Bridge Design Engr., State Highway Comm., Box 821, Baton Rouge, La.

Punyagupta, Soonchong Boon (Jun. '26; Assoc. M. '36), Engr. in Chg., Technical Office, Royal State Rys. of Siam, Bangkok, Siam.

Reed, Ralph (Jun. '28; Assoc. M. '36), Asst. City Engr. (Res., 215 Fifth St., S.E.), Watertown, S.Dak.

TOTAL MEMBERSHIP AS OF SEPTEMBER 9, 1936

Members	5,630
Associate Members	5,896
Corporate Members	11,526
Honorary Members	19
Juniors	3,052
Affiliates	89
Fellows	1
Total	14,687

Rustan, Arvid Konrad (Jun. '28; Assoc. M. '36), Supt. of Constr., Oslo Vann & Kloakvesen, Oslo, Norway.

Salmen, Clifford Ross (Jun. '29; Assoc. M. '36), Asst. Highway Engr., U. S. Bureau of Public Roads, Box 391, Ogden, Utah.

Stemm, Howard John (Jun. '30; Assoc. M. '36), Engr., Swift & Co., Mech. Dept., National Stock Yards, Ill.

Wallin, Carl Jorgan (Jun. '29; Assoc. M. '36), Res. Engr., Virginia Hot Springs Co., Box 116, Hot Springs, Va.

Wheeler, Ralph Norman (Assoc. M. '03; M. '36), Cocoa, Fla.

Wolf, Clemens William Henry (Jun. '31; Assoc. M. '36), Res. Engr., Fargo Eng. Co. (Res., 909 South Wisner St.), Jackson, Mich.

Wood, Robert Walter (Jun. '07; Assoc. M. '09; M. '36), Engr. in Chg. of Field Work, Borough of Richmond, New York (Res., 405 Bement Ave., West New Brighton), N.Y.

Wright, Chilton Austin (Jun. '22; Assoc. M. '27; M. '36), Hydr. Engr., National Hydr. Laboratory, National Bureau of Standards, Washington, D.C.

REINSTATEMENTS

Bateman, John Henry, M., reinstated Aug. 24, 1936.

Hartung, Paul August, M., reinstated Aug. 18, 1936.

Robinson, George Norman, M., reinstated Aug 17, 1936.

Wilson, Carl Amos, Assoc. M., reinstated Aug. 17, 1936.

RESIGNATIONS

Clover, Ira Newton, Assoc. M., resigned Aug. 28, 1936.

Moreland, Eldon Wright, Assoc. M., resigned Aug. 11, 1936.

Noser, Joe Edward, Jun., resigned Aug. 12, 1936.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

October 1, 1936 NUMBER 10

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years †	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Allis, John Arthur, Stillwater, Okla. (Age 32.) Asst. Engr., U. S. Geological Survey, Soil Conservation Service. Refers to J. H. Gardiner, N. C. Grover, T. R. Newell, C. G. Paulsen, A. B. Purton, M. T. Wilson.

Anderson, Carl Alfred, Albuquerque, N.Mex. (Age 44.) Chf. Engr., Middle Rio Grande Conservancy Dist. Refers to C. T. Bartlett, J. L. Burkholder, R. G. Hosea, G. M. Neel, H. C. Neuffer.

Appleman, Harry, Brooklyn, N.Y. (Age 23.) Refers to W. Allan, R. E. Goodwin, T. H. Prentice, J. C. Rathbun, W. L. Willig.

Arksey, Wilbert Foster, Duluth, Minn. (Age 21.) Refers to F. Bass, A. S. Cutler, O. M. Leland.

Ayre, Robert Stevenson, Stanford University, Calif. (Age 24.) Refers to S. B. Morris, L. B. Reynolds, J. B. Wells.

Bamberger, Sidney Francis, Pasadena, Calif. (Age 24.) Refers to R. R. Martel, F. Thomas.

Bennett, Chilton Gordon, Canyon, Tex. (Age 32.) Senior Engr. (has been appointed Asst. Regional Engr.), National Park Service. Refers to H. T. Boyle, H. E. Elrod, E. B. Gore, C. J. Howard, P. F. Rossell, B. F. Williams.

Bennett, James Edward, Jr., New York City. (Age 23.) Refers to J. J. Costa, A. V. Sheridan.

Brown, Roy Tilson, Knoxville, Tenn. (Age 51.) Asst. Prof., Dept. of Civ. Eng., Univ. of Tennessee. Refers to N. W. Dougherty, H. H. Hale, T. F. Hickerson, T. K. Legare, G. E. Tomlinson, H. A. Wiersema.

Callinan, Bernard James, Melbourne, Australia. (Age 23.) With A. Gordon Gutteridge, under direct supervision of P. M. James, Shire Engr., Bairnsdale, Victoria. Refers to G. Higgins, W. H. R. Nimmo, W. M. Pullar, C. W. N. Sexton, H. M. Sherrard.

Campbell, Joseph Garden, Hongkong, China. (Age 34.) Constr. Engr. with Messrs. Binnie, Deacon & Gourley. Refers to W. J. E. Binnie, G. B. G. Hull, A. K. Pollock. (Applies in accordance with Sec. 1, Art. I, of the By Laws.)

Carter, George Remington, Rushville, Ind. (Age 21.) Refers to C. A. Ellis. R. B. Wiley.

Christiani, Henning Oldenburg, New York City. (Age 25.) Engr. with Madigan-Hyland. Refers to S. Johannesson, E. Praeger.

Cipolla, Arthur Safford, Montclair, N.J. (Age 24.) With Resettlement Administration, Hightstown, N.J. Refers to L. W. Clark, H. B. Compton, T. R. Lawson, H. O. Sharp, E. R. Wiseman.

Clark, Leon Herbert, Kingston, N.Y. (Age 26.) Res. Engr. with Solomon & Keis. Refers to H. O. Sharp, G. R. Solomon.

Comella, William Oliver, Chestertown, Md. (Age 23.) Refers to T. F. Hubbard, J. T. Thompson.

Coppinger, Cyril, New York City. (Age 22.) Refers to J. J. Costa, A. V. Sheridan.

Corbett, James Phillip, Harrisburg, Ill. (Age 26.) Project Technician, WPA. Refers to J. G. Bennett, A. J. Hammond.

Crandall, Frederick Bruce, Timber, Ore. (Age 30.) Computor, Oregon State Highway Dept. Refers to F. Merryfield, C. A. Mockmore.

Crook, Leonard Thomas, Albuquerque, N. Mex. (Age 22.) Refers to J. H. Dorroh, R. H. A. Rupkey.

Csendes, Francis Emile, New York City. (Age 26.) Refers to W. Allan, R. E. Goodwin.

Culp, Frank Edward, Tacoma, Wash. (Age 27.) Inspector of steel and timber bridges, Washington State Highway Dept. Refers to C. C. More, C. W. Nash, F. H. Rhodes, Jr.

Cundari, Joseph Anthony, Harrison, N.J. (Age 22.) Refers to J. J. Costa, A. V. Sheridan.

Curl, Stoddard Whinfield, Memphis, Tenn. (Age 23.) Under Eng. Aide, TVA. Refers to E. D. Roberts, F. W. Ullius.

Darling, Horace Velpeau, Arlington, Va. (Age 33.) With U. S. Govt., Board of Engrs., for Rivers and Harbors, Office of Chf. of Engrs., War Dept., Washington, D.C. Refers to V. M. Cone, G. E. Edgerton, J. R. Lapham, M. Macartney, L. D. Norsworthy, B. B. Somervell, W. B. Williamson.

Deegan, Edward Joseph, Brooklyn, N.Y. (Age 23.) Refers to J. J. Costa, A. V. Sheridan.

Demarest, Richard Terhune, New York City. (Age 20.) Refers to H. E. Breed, C. T. Schwarze.

Diker, Vejdi Rifat, Columbia, Mo. (Age 24.) Refers to R. B. B. Moorman, H. K. Rubey.

Dozier, Louis Sanford, Jacksonville, Fla. (Age 29.) Constr. Engr., H. E. Turner Constr. Co. Refers to J. M. Angle, C. D. Gibson, S. Gordy, C. C. Newsom, C. L. Rhodes, M. L. Shadburn, F. C. Snow.

Drew, Freeman Pierce, Des Moines, Ia. (Age 22.) Draftsman, Pittsburgh-Des Moines Steel Co. Refers to A. H. Fuller, F. Kerekes.

Dvorachek, William Henry, Fayetteville, Ark. (Age 24.) Refers to N. B. Garver, W. R. Spencer.

Ebbets, Lawrence Otzen, San Francisco, Calif. (Age 29.) Member of firm, Irvine & Ebbets, Archts. & Engrs.; also with U. S. Govt., Forestry Service. Refers to G. F. Carney, H. A. Ciufi, I. Gottheim, E. R. Huber, K. E. Parker, E. L. Soule, F. H. Spitzer.

Elfendahl, William Preston, Seattle, Wash. (Age 21.) Draftsman, Boeing Airplane Co. Refers to C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

Ell, Henry Theodore, Cambridge, Mass. (Age 29.) Refers to G. M. Fair, A. Haertlein, H. N. Lendall, W. Rudolfs, H. M. Turner.

Evans, George William, McHenry, Miss. (Age 22.) Rodman, Mississippi State Highway Dept. Refers to R. P. Black, F. C. Snow.

Fales, Kenneth Frank, Medford, Mass. (Age 21.) Refers to H. P. Burden, R. W. Lefavour, F. N. Weaver.

Findeisen, John George, Jr., Peoria, Ill. (Age 21.) Apprentice Engr., Caterpillar Tractor Co. Refers to H. B. Compton, T. R. Lawson, W. J. Wilgus.

Flay, George Francis, Jr., Astoria, N.Y. (Age 24.) Job Engr., Spencer, White & Prentis, Inc., New York City. Refers to H. P. Hammond, H. T. Immerman, E. A. Prentis, C. B. Spencer, L. White.

Floyd, Harold Sheeler, Hawthorne, N.J. (Age 21.) Refers to E. R. Cary, H. O. Sharp.

Francis, James Carlton, Jr., Galveston, Tex. (Age 28.) Jun. Engr., U. S. Engr. Dept. Refers to F. L. Bramlette, T. C. Forrest, Jr., T. B. Larkin, C. R. Little, E. N. Noyes, R. B. Tinsley, W. O. Washington.

Gallagher, Walter Vincent, Los Angeles, Calif. (Age 24.) Refers to C. L. Eckel, E. W. Raeder.

Galpin, Edward Glann, Pottstown, Pa. (Age 25.) Draftsman, Bethlehem Steel Co. Refers to F. A. Barnes, J. E. Perry.

Gilman, Roger Howe, Plainfield, N.J. (Age 22.) Refers to D. G. Edwards, W. L. Hanavan, T. R. Kendall.

Glasser, Arthur Frederick, Sewickley, Pa. (Age 22.) Estimator and Engr., Dravo Contr. Co., Pittsburgh, Pa. Refers to F. A. Barnes, J. E. Perry, C. L. Walker.

Gould, Robert Sewall, Sacramento, Calif. (Age 24.) Jun. Topographic Engr., U. S. Geological Survey. Refers to C. Derleth, Jr., F. S. Foote, C. G. Hyde, H. H. Hodgeson, C. H. Snyder.

Greene, William Jeff, Jr., Fairburn, Ga. (Age 22.) Refers to R. P. Black, H. S. Gibboney, F. C. Snow.

Greenleaf, John Whittier, Jr., Boston, Mass. (Age 27.) With Bayard F. Snow, X. Henry Goodnough, Inc. Refers to H. B. Alvord, E. A. Gramstorff, F. H. Kingsbury, B. F. Snow, A. D. Weston.

Grosso, Samuel John, Syracuse, N.Y. (Age 20.) Chairman, New York Central Lines. Refers to E. F. Berry, E. F. Church, G. D. Holmes, L. Mitchell, S. D. Sarason.

Grumbles, Maurice Wooten, Dallas, Tex. (Age 21.) Office Draftsman, Austin Bridge Co. Refers to E. C. H. Bantel, P. M. Ferguson, S. P. Finch, J. A. Focht, T. U. Taylor.

Hall, Frank Bell, Baltimore, Md. (Age 20.) Refers to T. F. Comber, Jr., J. H. Gregory, T. F. Hubbard, F. W. Medaugh, J. T. Thompson.

Hedrick, Ira Grant, Jr., Little Rock, Ark. (Age 23.) Draftsman with H. R. Carter. Refers to E. E. Bloss, H. R. Carter, R. J. Middleton, W. R. Spencer, R. L. Tatum.

Heintskill, Peter Nicolas, Milwaukee, Wis. (Age 25.) Draftsman and Designer with Robert Cramer & Sons, Cons. Engrs. Refers to E. D. Roberts, F. W. Ullius.

Hendricksen, Paul John, Decatur, Ill. (Age 24.) Refers to J. J. Doland, W. C. Huntington.

Hodges, Herbert Lloyd, Jr., Brooklyn, N.Y. (Age 28.) Inventory Asst., 3d Grade, Brooklyn Edison Co. Refers to C. C. Brown, T. M. Lowe, P. L. Reed.

Hunter, Joseph Greenwood, Burlingame, Calif. (Age 51.) Transportation Engr., Eng. Dept., California R. R. Comm., San Francisco, Calif. Refers to C. E. Andrew, W. Hall, H. B. Hammill, A. G. Mott, C. H. Purcell, J. J. H. Sharon.

Hyde, Edward Ruddock, Manila, Philippine Islands. (Age 53.) Prof. and Head, Dept. of Civ. Eng., also, Dean of Coll. of Eng., Univ. of the Philippines (State Univ.). Refers to A. Bolinas, Jr., A. W. Dean, W. J. Grodske, C. Hildabrand, H. D. Loring, P. W. Mack, C. F. Maynard.

Judah, Courtney Thomas, Watsonville, Calif. (Age 33.) Asst. Dist. Engr., U. S. Dept. of Agriculture, Soil Conservation Service. Refers to G. D. Clyde, R. A. Floyd, O. W. Israelsen, R. H. Jamison, T. R. Newell, G. Stubblefield.

Karadjopoulos, Georges Constantin, Serres, Greece. (Age 24.) Asst. Engr., John Monks & Sons- Ulen & Co. Refers to J. S. Crandell, J. J. Doland, W. C. Huntington, W. J. Judge, E. S. Sheiry.

Kehoe, Edward James, Brooklyn, N.Y. (Age 22.) Refers to J. J. Costa, A. V. Sheridan.

Kennedy, Charles Thomas, Cincinnati, Ohio. (Age 39.) In private practice. Refers to C. B. Breed, H. W. Hanly, P. Jones, H. D. Loring, F. F. McMinn, W. V. Schmiedeke, C. M. Spofford, W. B. Ward.

Kestner, Joseph Aloysius, Jr., Schenectady, N.Y. (Age 22.) With B. M. Stark, Rensselaer Polytechnic Institute, Troy, N.Y. Refers to H. B. Compton, T. R. Lawson, H. O. Sharp.

Ketcham, Earl Francis, North Platte, Nebr. (Age 41.) Superv. Engr. Inspector, PWA, Hydro-Elec. Development. Refers to R. M. Green, R. O. Green, E. E. Halmos, C. J. McNamar, J. G. Mason, D. D. Price, K. E. Vogel.

Kurkciyan, Simon Yetvart, Istanbul, Turkey. (Age 24.) Refers to J. S. Crandell, H. Cross, J. J. Doland, M. L. Enger, W. C. Huntington.

Laflin, Eli Forbes, Sacramento, Calif. (Age 22.) Jun. Eng. Aid, Materials and Research Laboratory, California Div. of Highways. Refers to B. A. Etcheverry, S. T. Harding.

Langbein, Leland Henry, Franklin Park, N.J. (Age 21.) Refers to H. N. Lendall, P. S. Wilson.

Lanham, Stanley Matthew, Los Angeles, Calif. (Age 31.) Public Utilities Engr., City Attorney, City of Los Angeles. Refers to R. C. Ashworth, D. M. Baker, C. K. Bowen, M. Butler, J. O. Marsh.

Laucomer, George Franklin, Detroit, Mich. (Age 22.) Recorder, U. S. Bureau of Reclamation, Denver, Colo. Refers to R. L. Downing, F. R. Dungan, C. L. Eckel, P. J. Preston.

Leahy, Philip Cousens, Whitney Point, N.Y. (Age 24.) Engr., WPA, Binghamton, N.Y. Refers to W. J. Farrisee, F. C. Wilson.

Learned, Alvah Chester, El Paso, Tex. (Age 22.) Refers to P. M. Ferguson, J. A. Focht.

Levine, Lewis, Brooklyn, N.Y. (Age 36.) Superv., Engr., Div. of Design, WPA, New York City. Refers to H. C. Dinney, H. P. Hammond, H. G. Hauck, E. J. Squire, S. E. Stott.

Li, Fon, Atlanta, Ga. (Age 26.) Refers to R. P. Black, C. D. Gibson, F. C. Snow.

Loewenthal, Julius, New York City. (Age 28.) Refers to H. P. Hammond, E. J. Squire.

Luippold, Jerome William, Buffalo, N.Y. (Age 22.) Chainman, Eng. Dept., Bethlehem Steel Corporation, Lackawanna, N.Y. Refers to F. A. Barnes, E. N. Burrows.

McKesson, Eldred Kenney, Berkeley, Calif. (Age 22.) Refers to C. Derleth, Jr., B. Jameyson, C. L. McKesson.

McManus, John Ferdinand, Rochester, N.Y. (Age 22.) Eng. Inspector, Eastman-Kodak Co. Refers to F. A. Barnes, C. Crandall, J. E. Perry.

McNown, John Stephenson, Lawrence, Kans. (Age 20.) Rodman, Kansas State Highway Dept. Refers to G. W. Bradshaw, D. D. Haines, J. O. Jones, W. C. McNown, F. A. Russell.

Maher, Francis Joseph, Brooklyn, N.Y. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

Maiale, Anthony Joseph, Bridgeport, Pa. (Age 23.) Refers to H. L. Bowman, S. J. Leonard.

Maloney, Pirie Joseph, Forest Hills, N.Y. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

Matthews, William Albert, Denver, Colo. (Age 20.) Refers to H. S. Crocker, C. L. Eckel, R. C. Gowdy.

Mauro, Gasper Maria, Brooklyn, N.Y. (Age 33.) Senior Engr., WPA, Park Dept. Refers to R. E. Goodwin, G. T. Larson, J. C. O'Dea, F. G. Parisi, J. C. Riedel.

Meihofer, Anthony Rudolph, Baltimore, Md. (Age 26.) Refers to S. A. Becker, M. O. Fuller, L. J. H. Grossart, E. M. Killough, C. H. Sutherland.

Meranda, Norman Eugene, Springfield, Ohio. (Age 22.) Refers to L. H. Gardner, A. R. Webb.

Mortimer, Winfield Stout, Colfax, Wash. (Age 29.) Refers to H. E. Phelps, M. K. Snyder.

Naismith, James Sherman, Dallas, Tex. (Age 23.) With Myers, Noyes & Forrest, Cons. Civ. Engrs. Refers to A. T. Cook, T. C. Forrest, Jr., W. H. Meier, E. L. Myers, E. N. Noyes, C. S. Reagan.

Nash, Norman, Brooklyn, N.Y. (Age 20.) Student Technician, Camp SP-33, CCC Co. 275, Moravia, N.Y. Refers to W. Allan, R. E. Goodwin.

Nutter, Ben Earl, Los Angeles, Calif. (Age 25.) Refers to N. Bostwick, J. R. Griffith, C. A. Mockmore.

Olander, Harvey Chester, Denver, Colo. (Age 28.) Jun. and Associate Engr., U. S. Bureau of Reclamation. Refers to E. O. Bergman, C. L. Eckel, H. R. McBirney, E. W. Raeder, R. Sailer, C. P. P. Vetter.

O'Shea, Thomas Joseph, New York City. (Age 22.) Refers to J. J. Costa, A. V. Sheridan.

Parratt, Lyle Franklin, Washington, D.C. (Age 22.) Refers to A. N. Johnson, S. S. Steinberg.

Patton, John Murray, Narberth, Pa. (Age 22.) Foreman, Steele Bldg. Constr. Co., Inc., Philadelphia, Pa. Refers to H. B. Shattuck, E. D. Walker.

Peterson, Carlton James, Anaheim, Calif. (Age 22.) With Los Angeles Dept. of Power and Light, Independence, Calif. Refers to G. H. Dunstan, R. M. Fox, E. P. Hapgood, A. Jones, D. M. Wilson.

Peterson, James Marslowe, Avondale Estates, Ga. (Age 22.) With Mississippi State Highway Dept., Bassfield, Miss. Refers to R. P. Black, F. C. Snow.

Piepoli, Nicholas Francis, Bronx, N.Y. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

Prince, Clyde Duane, New York City. (Age 22.) Helper, Signal Dept., New York Central R. R. Refers to E. W. Bowler, R. R. Skelton.

Pulido y Morales, Rene Saturnino, Havana, Cuba. (Age 31.) In private practice. Refers to J. A. Cosculluela y Barreras, J. Garcia Montes, A. M. Lopez, M. Villa Rivera, W. R. Young.

Randall, Rex Ray, Oakland, Calif. (Age 50.) Head, Dept. of Civ. Eng., Polytechnic Coll. of Eng.; also Civ. Engr. for E. T. Minney Co., Realtors. Refers to C. E. Beugler, C. H. Boardman, C. Derleth, Jr., C. G. Hyde, G. Mattis.

Reichmann, Albert Ferdinand, Jr., Frackville, Pa. (Age 22.) Refers to J. J. Doland, L. C. Rogers.

Ringelstein, Albert Charles, Bronx, N.Y. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

Robertson, Gordon Walter, Sacramento, Calif. (Age 23.) With Henry D. Dewell, San Francisco, Calif. Refers to A. W. Johnson, S. S. Steinberg, W. J. Stich.

Rogers, Donald Frederick, Rochester, N.Y. (Age 24.) Refers to T. R. Lawson, H. O. Sharp.

Rollins, Robert Hood, Alhambra, Calif. (Age 24.) Refers to O. F. Cooley, R. M. Fox, W. J. Fox, A. Jones, D. M. Wilson.

Rossow, Carl John, Barberton, Ohio. (Age 23.) Draftsman, Eng. Dept., Babcock & Wilcox Co. Refers to F. A. Barnes, J. E. Perry.

Ruth, Joseph Francis, Bronx, N.Y. (Age 20.) Refers to J. J. Costa, A. V. Sheridan.

Sack, Adam Francis, Baltimore, Md. (Age 29.) Rodman, Bethlehem Steel Co. Refers to H. L. Bowman, S. J. Leonard.

Shamburger, Roy Thomas, Ft. Worth, Tex. (Age 27.) Refers to O. V. Adams, J. H. Murdough, G. W. Parkhill.

Shultz, Maurice Leonard, Pleasantville, N.J. (Age 23.) Refers to H. L. Bowman, S. J. Leonard.

Sloss, Donald Webster, Pasadena, Calif. (Age 24.) Chainman and Rodman, Metropolitan Water Dist. of Southern California. Refers to C. G. Hyde, C. T. Wiskocil.

Smith, Charles Pixley, Houston, Tex. (Age 48.) Res. Engr. Inspector, U. S. Bureau of Public Roads, Ft. Worth, Tex. Refers to R. P. Boyd, J. B. Dannenbaum, J. M. Howe, R. V. Lindsey, W. W. McClendon, J. M. Page.

Smith, Walter Lane, Memphis, Tenn. (Age 28.) Pres., Memphis Stone & Gravel Co. Refers to G. E. Beggs, F. H. Constant, P. Kissam, L. W. Mashburn, E. C. Wild.

Sparrow, George Bradley, Camden, N.J. (Age 21.) Refers to H. L. Bowman, S. J. Leonard.

Stauble, John Henry, Port of Spain, Trinidad, B.W.I. (Age 28.) Asst. Engr., Edmund Nuttall Sons & Co. (Manchester) Ltd. Refers to E. C. Buck, J. J. Costa, G. L. Freeman, S. W. McClave, Jr., J. A. Ruddy.

Stern, Adolph Benjamin, Brooklyn, N.Y. (Age 24.) Jun. Estimator and Asst. to Office Mgr., Jeffrey Mfg. Co. Refers to R. C. Brumfield, F. E. Foss, M. H. Van Buren.

Stirman, Harry Hill, Eagle Pass, Tex. (Age 30.) Asst. Engr., Maverick County Water Control & Improvement Dist. No. 1. Refers to T. C. Forrest, Jr., C. Manes, E. L. Myers, E. N. Noyes, C. S. Reagan, R. B. Thomas.

Sturdy, Howard Henry, Sewickley, Pa. (Age 23.) Engr. and Estimator, Dravo Contr. Co., Neville Island Branch, Pittsburgh, Pa. Refers to F. A. Barnes, J. E. Perry, N. H. Sturdy, C. L. Walker.

Taragin, Asriel, Baltimore, Md. (Age 21.) Senior Draftsman, Maryland State Planning Comm., State Health Dept. Refers to J. H. Gregory, T. F. Hubbard, F. W. Medaugh, J. T. Thompson, A. Wolman.

Teichert, Frederick Quaas, Sacramento, Calif. (Age 21.) Refers to C. Derleth, Jr., B. A. Etcheverry, S. T. Harding.

Telemaque, Lionel Jean Baptiste Marie, Port-au-Prince, Haiti. (Age 35.) Prof., State School of Applied Sciences, Port-au-Prince, Haiti, School of Eng., Govt. of Haiti. Refers to W. M. Fife, G. Gilboy, A. L. Jacobson, C. M. Spofford, C. H. Sutherland, R. G. Tyler, J. B. Wilbur.

Thompson, Clement Craig Caton, Hinsdale, Ill. (Age 27.) With Carnegie-Illinois Steel Co., Chicago, Ill. Refers to J. G. Bennett, D. H. Seaman, H. van Zandt.

Thoren, Clarence Christ, Burbank, Calif. (Age 25.) Refers to R. M. Fox, D. M. Wilson.

Thoroughman, Frank Marion Mathewson, St. Louis, Mo. (Age 25.) Student Engr., War Dept., Corps of Engrs., U. S. Engr. Office, Alton, Ill. Refers to C. E. S. Bardsley, J. B. Butler, L. B. Feagin, P. S. Reinecke, J. W. Skelly.

Van Buren, Edgar Sexton, Valhalla, N.Y. (Age 21.) Refers to E. Anderberg, L. V. Carpenter, J. Downer, C. A. Garfield, A. G. Hayden, T. Saville, C. T. Schwarze.

Van Rensselaer, Franklin Lord, Morris, N.Y. (Age 23.) Refers to L. W. Clark, T. R. Lawson, H. O. Sharp.

Wallace, Virgil Ancil, Morris, Okla. (Age 24.) Res. Engr. with WPA, Hughes County, Okla. Refers to W. R. Grace, T. P. Paxton, W. R. Spencer, W. H. Wheatley.

Warren, Frederick Hayes, Washington, D.C. (Age 26.) With RFC. Refers to G. E. Beggs, F. H. Constant, W. L. Drager, J. A. Fraps, W. W. Lane, R. V. Leeson, M. Macartney.

Weeks, William Alfred, Ridgewood, N.Y. (Age 29.) Station Master, Board of Transportation, New York City. Refers to H. P. Hammond, L. F. Rader, E. J. Squire.

Weight, William King, Bishop, Calif. (Age 25.) Refers to C. G. Hyde, B. Jameyson, C. T. Wiskocil.

Weiss, Bernard Samuel, Philadelphia, Pa. (Age 22.) Refers to D. B. Steinman, C. H. Sutherland.

Werblow, Joseph Morton, New York City. (Age 21.) Asst. Engr., P. T. Cox Contr. Co. Refers to W. Allan, R. E. Goodwin, J. S. Peck, J. C. Rathbun.

Wilkinson, Conrad Hopf, Philadelphia, Pa. (Age 24.) Refers to H. L. Bowman, S. J. Leonard.

Withers, Carroll Everett, State College, N. Mex. (Age 27.) Extension Engr., U. S. Extension Service, U. S. Dept. of Agriculture. Refers to E. L. Barrows, J. H. Dorroh, B. Johnson, H. C. Neuffer, S. H. Sims.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Allison, William Henry, Assoc. M., Potsdam, N.Y. (Elected March 11, 1929.) (Age 44.) Asst. Prof. of Civ. Eng., Clarkson Coll. of Technology. Refers to C. T. Bishop, A. B. Ilsley, R. H. Suttie, J. C. Tracy, F. C. Wilson.

Beebe, Lucian Harrison, Assoc. M., Quaker Hill, Conn. (Elected Aug. 9, 1920.) (Age 48.) Project Engr., Connecticut Highway Dept., Hartford, Conn. Refers to G. L. Bilderbeck, A. W. Bushell, C. A. Campbell, G. E. Hamlin, S. B. Palmer, E. D. Parker, I. W. Patterson, W. H. Sharp, L. M. Young.

Bisset, John Clifford, Assoc. M., San Antonio, Tex. (Elected Junior Dec. 15, 1924; Assoc. M. March 11, 1929.) (Age 36.) Asst. State Director, Div. of Operations, Texas WPA. Refers to E. A. Baugh, A. G. Classen, H. W. English, J. T. L. McNew, E. L. Myers, E. N. Noyes, F. A. Russell.

Galt, Charles Elijah, Assoc. M., Ferguson, Mo. (Elected Nov. 27, 1917.) (Age 48.) Lecturer, Washington Univ., Chf. Engr., Atlas Iron Works, St. Louis, Mo. Refers to W. C. E. Becker, R. B. Brooks, A. P. Greensfelder, W. W. Horner, W. E. Rolfe, E. O. Sweetser, F. C. Woermann.

Guerdrum, George Hagbart, Assoc. M., San Antonio, Tex. (Elected May 31, 1916.) (Age 58.) In private practice. Refers to O. D. Filley, H. R. F. Helland, A. W. Parker, W. E. Simpson, G. S. Smith, F. J. Trumpour, W. H. Waugh.

Hamilton, William Henry, Assoc. M., Denver, Colo. (Elected Junior Oct. 1, 1926; Assoc. M. June 9, 1930.) (Age 35.) Associate Engr., U. S. Bureau of Reclamation. Refers to H. F. Anthony, E. B. Debler, S. O. Harper, R. A. Monroe, W. H. Nalder, J. L. Savage, R. F. Walter.

Kilcarr, Gilbert Michael, Assoc. M., New York City. (Elected Sept. 12, 1921.) (Age 44.) Vice-Pres., Interstate Equipment Corporation. Refers to E. H. Burroughs, Jr., T. E. Collins, F. C. Hitchcock, L. A. Robb, D. B. Steinman, S. W. Stewart.

Kingscott, Louis Clifton, Assoc. M., Kalamazoo, Mich. (Elected Junior July 9, 1923; Assoc. M. Nov. 15, 1926.) (Age 38.) Member of firm, Stewart-Kingscott Co., Archts. and Engrs. Refers to J. H. Cissel, G. H. Fenkell, L. M. Gram, G. D. Kennedy, A. Lenderink, H. E. Riggs, F. E. Simpson.

Overshiner, William Humphreys, Assoc. M., Santa Ana, Calif. (Elected Jan. 14, 1929.) (Age 43.) Lt.-Commander, C.E.C., U. S. Naval Reserve; Asst. Engr., Orange County Flood Control Dist. Refers to B. A. Etcheverry, F. H. Hardy, E. O. Heaton, W. W. Hoy, R. R. Lukens, G. A. McKay, T. H. Means, G. T. Rude, P. C. Whitney.

From the Grade of Junior

Andrew, Robert Morrison, Jun., Indianapolis, Ind. (Elected Oct. 30, 1933.) (Age 28.) Project Engr., Senior Grade, State Highway Comm. of Indiana. Refers to C. A. Broecker, J. T. Hallett, C. Hunnell, Jr., A. R. Smith, C. E. Vogelgesang, H. L. White.

Benson, Mons Herman, Jun., Knoxville, Tenn. (Elected Feb. 10, 1930.) (Age 32.) Asst. Structural Engr., TVA. Refers to A. S. Cutler, L. W. Goddard, H. W. King, O. Laurgaard, B. W. Steele, C. P. P. Vetter.

Coltrin, Kenneth Louis, Jun., Portland, Ore. (Elected July 16, 1928.) (Age 32.) Asst. Engr., and Eng. Asst. to Prin. Engr., U. S. War Dept., Bonneville Project. Refers to H. F. Blood, R. E. Davis, S. De Moss, R. E. Mackenzie, F. H. Marsh, E. L. Soule.

Garnett, Ernest Edwin, Jr., Jun., San Francisco, Calif. (Elected Nov. 14, 1927.) (Age 32.) Civ. Eng. Inspector, San Francisco Water Dept. Refers to O. G. Goldman, F. H. Hardy, F. A. Kittredge, J. S. Lane, L. B. Reynolds, O. Speir, L. W. Stocker.

Hook, Addison Eastwick, Jun., Knoxville, Tenn. (Elected Jan. 14, 1929.) (Age 32.) Associate Office Engr., and Asst. to Head Engr., TVA. Refers to H. H. Allen, B. B. Brier, J. E. Greiner, J. V. Hogan, A. N. Johnson, P. M. Parker, S. S. Steinberg.

Ingram, William Truitt, Jun., Stockton, Calif. (Elected Dec. 22, 1930.) (Age 28.) San. Engr., San Joaquin Local Health Dist. Refers to N. Aanonsen, C. G. Gillespie, H. W. Haberkorn, C. G. Hyde, C. C. Kennedy, E. A. Reinke, L. B. Reynolds.

Laurent, Raymond Joseph, Jun., Baton Rouge, La. (Elected Nov. 11, 1929.) (Age 32.) Supervisor, state-wide highway planning surveys, U. S. Dept. of Public Roads. Refers to W. S. Guedry, N. E. Lant, B. W. Pegues, C. R. Shaw, I. W. Sylvester.

McCord, Herbert Weymouth, Jun., New York City. (Elected Oct. 1, 1928.) (Age 32.) Asst. Supt., Erection Dept., Post & McCord. Refers to J. B. Clermont, F. D. Hutchinson, C. E. Pett, F. L. Reynolds, A. Weymouth.

Milbank, Reginald Venn, Jun., New York City. (Elected June 4, 1928.) (Age 32.) Constr. Engr., Merritt, Chapman & Scott Corporation. Refers to H. K. Barrows, C. H. Gronquist, W. G. Grove, H. D. Robinson, D. B. Steinman.

O'Brien, Francis Joseph, Jun., Knoxville, Tenn. (Elected March 26, 1934.) (Age 30.) Supervisor of Inspection, TVA. Refers to A. J. Ackerman, J. G. Allen, P. J. Freeman, A. A. Meyer, H. E. Whitney.

Pitcher, Franklin, Jun., Knoxville, Tenn. (Elected Oct. 1, 1926.) (Age 32.) Asst. Examiner, TVA. Refers to R. P. Coble, J. W. Elliott, H. G. Hunter, J. S. Lewis, Jr., S. Quattlebaum, G. Slover.

Poli, Thomas, Jun., New York City. (Elected Oct. 26, 1931.) (Age 29.) Engr. WPA, Dept. of Hospitals, Brooklyn, N.Y. Refers to I. Hochstein, G. Morrison, D. Standley, M. H. VanBuren, G. Wallace.

Stevens, George, Jun., Olympia, Wash. (Elected April 18, 1927.) (Age 32.) Bridge Designer, Washington Dept. of Highways. Refers to C. C. Arnold, C. H. Eldridge, R. W. Finke, J. Jacobs, C. C. More, R. M. Murray, M. S. Woodin.

Sylvester, Harold MacTavish, Jun. Anacostia, D.C. (Elected Nov. 11, 1929.) (Age 33.) Asst. Public Works Officer, Naval Air Station. Refers to W. M. Angas, R. E. Bakenhus, L. W. Clark, P. J. Halloran, B. Moreell, E. C. Seibert, D. C. Webb.

Theobald, John Jacob, Jun., Valley Stream, N.Y. (Elected March 11, 1929.) (Age 32.) Asst. Prof. of Civ. Eng., Coll. of the City of New York; also Cons. Engr. Refers to J. K. Finch, R. E. Goodwin, W. J. Krefeld, J. S. Peck, J. E. Rathbun, J. F. Sanborn.

Van Liew, Roscoe Emerson, Jun., Denver, Colo. (Elected Oct. 30, 1933.) (Age 27.) Office Engr., Denver Office, PWA Inspection Div. Refers to R. K. Brown, G. M. Bull, E. B. Debler, M. Housecroft, F. M. Keller, R. B. Ketchum, F. H. Richardson.

Van Orman, Clare Ralston, Jun., Kansas City, Kans. (Elected April 30, 1934.) (Age 32.) Asst. Civ. Engr., Hydr. Eng. Sec., U. S. Engr. Dept. Refers to W. E. Baldry, G. A. Hathaway, D. H. McCoskey, W. C. McNown, H. K. Shane, L. B. Smith.

von Bergen, Harold Emil, Jun., Sacramento, Calif. (Elected July 14, 1930.) (Age 32.) Water Master (Jun. Engr., Hydr. Structural Design), Div. of Water Resources, State of California, Dept. of Water Rights, Burney, Calif. Refers to G. F. Engle, J. W. Gross, G. W. Hawley, I. M. Ingerson, W. A. Perkins, S. H. Searancke, T. R. Simpson, C. L. Young.

Weber, George, Jr., Jun., Waco, Tex. (Elected April 18, 1927.) (Age 32.) Asst. Hydr. Engr., U. S. Dept. of Agriculture. Refers to G. S. Beal, M. M. Bernard, N. C. Grover, J. C. Hoyt, J. W. Mangan, C. P. Paulsen, J. L. Saunders.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1936 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Erancisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

Civil Engineer; Jun. Am. Soc. C.E.; single; B.S.C.E. degree, 1929; 1½ years surveying experience; office and field work; 6 months engineering experience on water line; storm sewer and road construction; 3 years drafting-layout and detailing. Desires position in construction engineering in metropolitan area. Available in 15 days. D-5344.

DESIGN

Assistant Structural Engineer, Bonneville Project; Assoc. M. Am. Soc. C.E.; with U. S. Engineers; 16 years experience on highways, rivers and harbors, structural design, building construction, public utilities, railroad location, hydraulics, and administration; location, Pacific Coast or Western States. Graduate of University of Washington; 44 years old; Washington license. D-5231.

Civil and Sanitary Engineer; Jun. Am. Soc. C.E.; university degree; age 30; married; 6 years engineering experience. Design and construction of small sewerage plants, water-treatment plants, and swimming pools; general office engineering; concrete design; excellent draftsman; employed now; available on short notice. D-5234.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 36; New York license; 8 years design, estimating, and construction with general contractors on heavy construction projects and extension of power system; 8 years insurance brokerage. Knowledge of business principles and organization. Desires connection with future. Location immaterial. D-4964.

EXECUTIVE

Civil Engineer; M. Am. Soc. C.E.; technical graduate; married; 25 years varied engineering experience; drainage surveys, heavy railroad construction, including earthwork and bridges, mass transportation studies, and extensive valuation. Also engineer of maintenance of way in complete charge for large company. Available in about two weeks. Central states preferred. A-1864.

Highway and Bridge Engineer; Assoc. M. Am. Soc. C.E.; 42; married; 24 years experience in charge of all types of surveys, roads, and bridges. Desires location in or around Philadelphia, Wilmington, or Baltimore; employed; available on three weeks notice. D-5265.

Administrative, Industrial, Executive; M. Am. Soc. C.E.; employed—seeks association offering advantages; comparable 20 years experience, directing building design, specifications, securing bids, letting contracts, and maintenance and construction supervision. Experience on large and small projects throughout eastern seaboard—industrial plants, commercial buildings, and housing. Licensed architect and engineer. Record will permit critical investigation. B-8117.

Estimator; Assoc. M. Am. Soc. C.E.; age 44; married; 5 years field engineering on construction; 10 years estimator, in full charge of estimating both private and public work. Would like position with a general contractor, builder, or engineering organization. D-5236.

Consulting Engineer, Chicago, Ill.; M. Am. Soc. C.E.; 50; married; graduate civil engineer; registered structural engineer, Illinois; 28 years experience, large industrial plants, commercial building projects, appraisals, reports, etc.; established name in Chicago; available for association, or employment, with responsible engineering or construction organization. Will consider other desirable locations. B-7647.

Estimating Engineer; Assoc. M. Am. Soc. C.E.; 49; B.S. in C.E.; 10 years field experience in engineering and construction; 14 years experience as executive office engineer and building cost estimator. Employed for 10 years by one of country's largest building contractors, in full charge of estimating. Would like permanent position with high-class company. B-1141.

Builders' and Contractors' Engineer; Assoc. M. Am. Soc. C.E.; 39; thoroughly experienced with best firms on sales, estimates, purchases, designs—including falsework, construction, and surveys—on large buildings, public and private, also bridges, tunnels, and highways. Desires connection. C-6480.

Engineer; M. Am. Soc. C.E.; 30 years experience in engineering, maintenance of way, valuation, and executive departments of steam railroads—last 9 years on work requiring study and inspection of many railroads in the United States and Canada; desires connection in New York metropolitan area. D-4841.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 20 years experience as drainage, highway, railroad, and contractor's engineer; estimating, bidding jobs, superintendent of construction; on dredging, earth moving, bridges, drainage structures, foundations, docks, and sewers. Familiar with floating equipment. Available on about two weeks' notice. Southern states preferred. D-3490.

JUNIOR

Civil Engineer; Jun. Am. Soc. C.E.; single; 23; B.S. (civil), University of Missouri, 1935; 4 months experience as rodman, Missouri State Highway Department; 1 month as road contractor; 4 months as junior civil engineer, U. S. Forest Service; 3½ months as instrumentman in state park survey; desires position in any branch of civil engineering; location immaterial; available immediately. D-4735.